WELDERS TO THE NATION SINCE 1951

ador WELDING

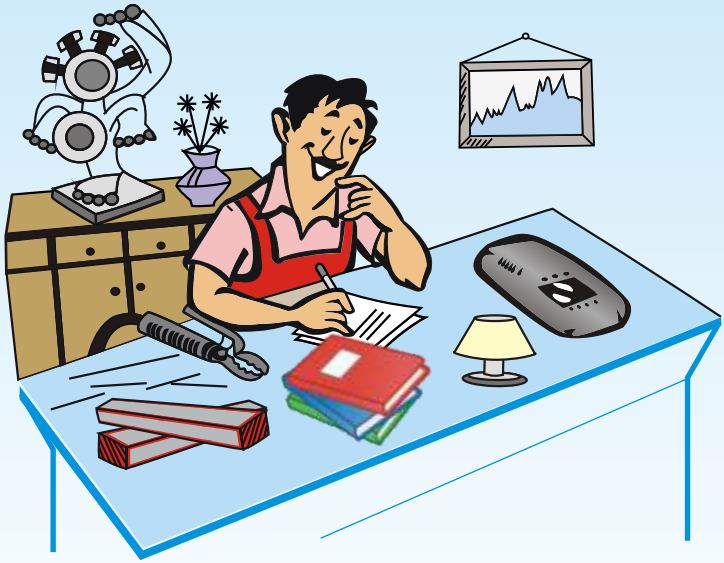
(Formerly Advani-Oerlikon Ltd.)

Thank You Mr. Welder

	CONTENTS	Page No.
Chapter 1	**DEAR MR. WELDER**	1
Chapter 2	**MANUAL METAL ARC WELDING (MMAW) ELECTRODES**	
	2.1 General Purpose Mild Steel Electrodes	3
	2.2 Basic Coated Low Hydrogen Electrodes	4
	2.3 Electrodes for Pipe Welding	6
	2.4 Low Alloy & High Tensile Steel Electrodes	7
	2.5 Hard Facing Electrodes	8
	2.6 Stainless Steels & Heat Resisting Steel Electrodes	10
	2.7 Duplex & Super duplex stainless steel	12
	2.8 Electrodes for Welding Non-Ferrous Alloys	13
	2.9 Electrodes for Welding Cast Iron	13
Chapter 3	**LOW HYDROGEN (BASIC COATED) ELECTRODES**	
	3.1 Precautions to be taken while using basic coated Electrodes	15
	3.2 Advantages of Vacuum Packaging (R2U)	16
Chapter 4	**PRODUCTIVITY WITH SMAW / MMAW ELECTRODES**	
	4.1 High Deposition Efficiency Electrodes	17
	4.2 Proper welding procedures for ensuring minimum or no rework	19
	4.3 Weld defects and procedures to minimize them	20
	4.4 Welding Sequence & Control of Distortion	22
	4.5 Hints for ensuring radiographic Quality Welds	23
	4.6 Safety rules for Manual Metal ARC Welding	24
Chapter 5	**GAS METAL ARC WELDING (GMAW) WIRES**	
	5.1 Solid Wires for CO_2 Welding	27
	5.2 Flux - cored Wires for CO_2 Welding	28
	5.3 Productivity with MIG/MAG Welding Wires	30
Chapter 6	**TUNGSTEN INERT GAS (TIG) WELDING WIRES**	31
Chapter 7	**SUBMERGED ARC WELDING (SAW) WIRES & FLUXES**	
	7.1 Wires for submerged ARC Welding (SAW)	33
	7.2 Fluxes for submerged ARC Welding (SAW)	34

CHAPTER 1

DEAR MR. WELDER

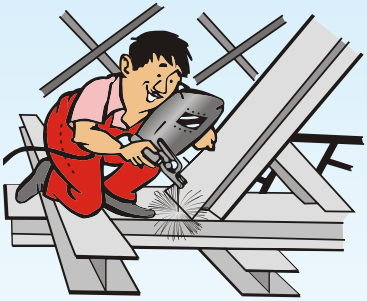


You belong to the proud family of welders whose significant role in nation - building is unquestionable! Welding is an integral part of every other industry - be it large, Medium, small or even workshops that may be tiny in comparison. In all industries such as Automobile, Shipping, Railways, Steel, Coal & Mine, Oil & Natural Gas, Chemical & Fertilizer, Food Processing and Infrastructure Development covering Irrigation, Rural Electrification, Housing and Water Supplies, fabrication or metal joining is an inseparable operation, making welders a key community in any development activity. Your role as a welder, therefore, requires you to deliver defect-free welds with the optimum use of consumables and without reworking.

Ador Welding Ltd. (formerly Advani-Oerlikon Limited), India's pioneer-leader in the welding industry has been a major supplier of a variety of welding consumables, equipment and systems for over half a century. The company has an impressive track record as a solutions provider to the welding fraternity and for innovation of new consumables and equipment for specific applications. Its well established and reputed **Technology Development Centre (TDC)** at Chinchwad, Pune has been serving the Engineering industry not only in terms of imparting skills training in welding to welders at various levels but has also been always responsible for dissemination of knowledge and information related to new developments in welding.

This book, **"Thank You Mr. Welder"** was first published in 1977 and since then, the reprinted editions have been widely used as a handy guide by the welding fraternity. Revised and updated by our Technical Team, this ready reckoner will be of significant help in achieving defect-free joints and in maximizing productivity. The book provides details of superior features of welding consumables that you can readily use. The welding consumables described herein include some popular manual metal arc welding electrodes, wires for TIG and MIG welding and consumables for submerged Arc Welding. Should you need further details in regard to specifications of any consumable, you may please (i) write to our nearest Area/ Territory/ Field Office (enlisted in the back section of this book) or (ii) to our Central Marketing Office at Chinchwad Plant, Survey No. 147 / 2B / 3, Near Khandoba Mandir, Akurdi Chowk, Chinchwad, Pune. You can also visit our website **www.adorwelding.com**

We have included some hints on when to use a low hydrogen basic coated electrode as well as the precautions to be taken. The benefits of using basic coated Vacuum Packed electrodes have also been described herein. Through this book, you will also learn how to increase productivity during manual welding operations as well as welding with SAW fluxes and consumables. The book also provides valuable insights on many day-to-day questions that you may raise while attempting to make a defect-free weld with nil or minimum rework for the purpose of maximizing productivity.



If you have specific welding related questions on which you need advice or wish to know about the welding courses offered by Technology Development Centre (TDC), simply send your queries to the following address:

Technology Development Centre (TDC):
CENTRAL MARKETING OFFICE
ADOR WELDING LIMITED
Chinchwad Plant, Survey No. 147 / 2B / 3, Near
Khandoba Mandir, Akurdi Chowk, Chinchwad,
Pune - 411019. Maharashtra. INDIA
Tel. No.: +91 20 4070 6000
Fax: +91 20 4070 6001
Email: cmo@adorians.com

You can be ensured of our response within 24 hours of receipt of your communication (excluding holidays). We trust this book will serve you as an invaluable reckoner in welding since the Technical Team of the Company has taken every effort to make this compilation serve that objective.

Yours Sincerely,

Aniruddha R. Vilekar
Head of Marketing (AWL)

CHAPTER 2

MANUAL METAL ARC WELDING (MMAW) ELECTRODES

The Ador Welding Limited range of (MMAW) electrodes can be classified into the following groups :

- General Purpose Mild Steel Electrodes
- Basic Coated Low Hydrogen Electrodes
- Electrodes for Pipe Welding
- High deposition efficiency Electrodes
- Low Alloy & High Tensile Steel Electrodes
- Hard Facing Electrodes
- Stainless and Heat Resisting steels Electrodes
- Non Ferrous Electrodes
- Electrodes for Cast Iron Welding

We are describing below the superior features of some popular electrodes from each group.

2.1 General Purpose Mild Steel Electrodes

The popular electrodes in this range and their AWS / BIS classification are :

E Bond	E6013 / ER 4121
Metal Bond	E6013 / ER 4112 X
King Bond	E6013 / E 4211X
Super Bond	E6013 / ER 4212 X
Super Bond S	E6013 / ER 4222 X
Super Bond SS	E6013 / ERR 4222 X
Silox Fe	ES 4122

The superior features of these electrodes are briefly given below:

E BOND

A general purpose, all position, economical mild steel electrode designed for welding light structural work, where reasonable loads are present and reasonably good weld finish is essential (AC / DC).

METALBOND

A general purpose all position, economical mild steel electrode designed & developed for welding light structural work, wherever moderate loads are present and crack resistant X-ray quality welding is required (AC / DC).

KINGBOND

King in E6013 type. Medium rutile coated electrode with excellent weldability in vertical down also. Striking & restriking is very good. Weld metal is of radiography quality. Used in the steel plants, storage tanks, shipbuilding, etc

SUPERBOND

The favorite of Welders! Pleasing performance, soft arc, Good finish, all position electrode X-ray quality weld suitable for all types of structural welding. It has been used for welding leak-proof tanks, medium pressure piping, box wagons etc. (AC / D C).

SUPERBOND S

For all types of light, medium and heavy structural work. Excellent for all position welding in the shop and at side, for pressure tubes & pipes butt joints, tubes to plate joints. In small diameter pressure tubes, root runs can be made in all positions to obtain uniform root fusion & penetration and X-ray quality welds with ease. Lower gauges of Superbond S are best suited for welding sheet steel without the fear of burn-through (AC / DC).

SUPERBOND SS

Heavy coated electrode for touch type welding. Gives smooth flat bead with excellent finish, self peeling slag, relatively less level of smoke & fatigue to the welders. Excellent for X-ray or Radiographic quality weld for locomotive fire boxes, boiler & pressure vessels (AC / DC).

SILOX FE

This is a special mild steel electrode to deposit almost pure iron with a very low level of silicon for fabrication or maintenance welding of “hot dip galvanized bath tanks” using Dead Soft Quality (DSQ) steels. The weld deposit is fairly strong, highly ductile & resistant to corrosion, particularly by molten Zinc. It offers excellent arc stability, fine ripples and very easy slag removal (AC / DC -).

2.2 Basic Coated Low Hydrogen Electrodes

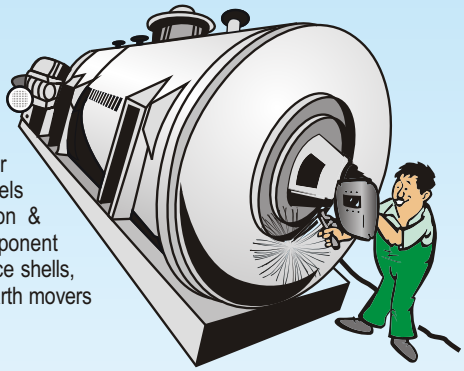
The popular electrodes in the range and their AWS / BIS Classification are:

Supabase	E7018 / EB 5426H3JX
Supabaxe X Plus	E7018 / EB 5426H3JX
Tenalloy Z Plus	E7018-1 / EB 5629H3JX
Tenalloy S Plus	E7018-1 H4 / EB 5629H4J XX
Tenalloy 16	E7016 / EB 5426H3 X
Tenalloy 16W	E7016/ E B5426H3X
Tenalloy HH (Spl)	E7018 / EB 5629 H3 X

The superior features of these electrodes are described below:

SUPABASE

An all position, low hydrogen, iron powder type electrode with excellent performance. Gives an excellent crack resistant, radiographic quality high-tensile weld with excellent toughness at -29°C. This is preferred for dynamically loaded structures and also for steels containing slightly higher percentage of carbon & sulphur. Recommended for joining heavy component parts of bridges, Industrial Building, Blast furnace shells, reactors, Rail coaches under frame assembly, Earth movers and heavy cast steel parts (AC / DC+).



SUPABASE X PLUS

A low hydrogen iron powder type electrodes for all position plate & pipe welding with exceptional welder appeal! It offers a crack resistant, high tensile & radiographic quality weld with easy slag detachability. This electrode is preferred for all types of dynamically loaded heavy structures. Recommended for joining heavy component parts of bridges, Industrial building, Blast furnace shells reactors, Pressure vessels, Under frame assembly of rail coaches, Earth movers and heavy cast steel parts (AC / DC+).

TENALLOY Z PLUS

A low hydrogen type, iron powder electrode for all position plate & pipe welding with exceptional arc Characteristics. Weld deposit of this electrode exhibits excellent toughness even at -46°C. The electrode deposits radiographic quality weld with effortless slag removal. It is an ideal electrode for joining heavy component parts of bridges subject to dynamic loading & mechanical restraint, Armoured vehicle, Earth movers, Pressure vessel and Heavy cast steel parts (AC / DC+).

TENALLOY S PLUS

It is an extra low hydrogen iron powder type electrode for all position plate & pipe welding with exceptional arc performance. Its weld deposit has S & P lower than 0.015, exhibits excellent toughness even at -60°C, is radiographic quality with easy slag detachability. It is an ideal electrode for joining heavy component parts of bridges for dynamic loading & mechanical restraint type joints, Armoured Vehicle, Heavy earth moving machinery parts, Pressure vessels, etc. (AC / DC +).

TENALLOY 16

It is low hydrogen electrode suitable to use as buffer layer for hard-surfacing, joining cast-iron to mild steel, joining rail ends, fixing of rails to mild steel girders and EN 8 steels. It offers deposit with easy slag removal, with excellent smooth & stable arc. Weld metal is of X-ray quality (AC / DC+).

Tenalloy 16W

A hydrogen controlled electrode having special type of lime coating. Produces smooth, clean deposit with very little spatter & slag easy to remove. Because of its special lime coating, trouble free welds are possible on difficult to weld steels such as high carbon, alloy, high sulphur, free machining & cold rolled steels

TENALLOY HH (SPL)

An extra low hydrogen iron powder, all position electrode specially recommended for welding steels where severe service conditions exist, particularly for NACE applications.

All the basic coated electrodes mentioned earlier can be supplied in vacuum packing (R2U), on demand. The benefits of using these vacuum packed electrodes (R2U) are listed in chapter 3.

2.3 Electrodes for Pipe Welding

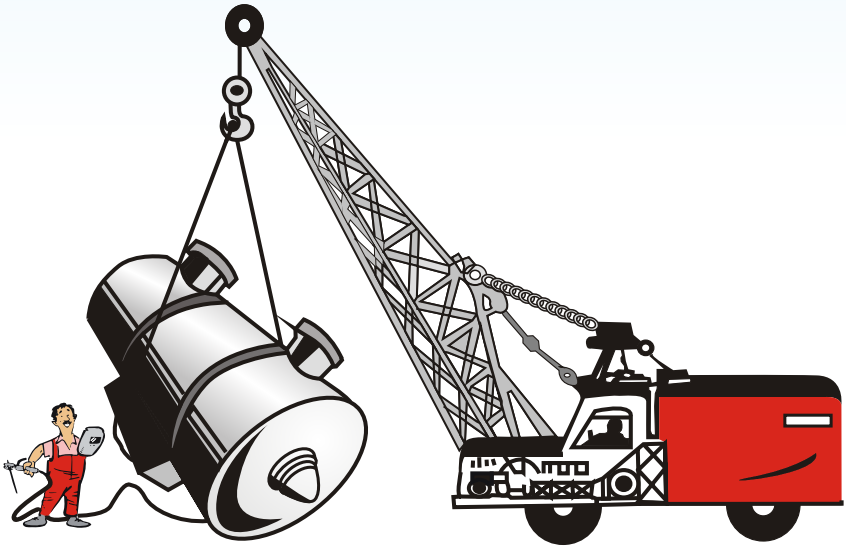
The popular electrodes in this range and their AWS / BIS classification are:

Celwel 60	E 6010 / E 433C25
Celwel 70 G	E 7010G / E 463C25
Celwel 80 G	E 8010G

CELWEL 60

It is very popular among the down hill/ stove pipe welders or those who are trained under the supervision of engineers from U.S.A & Canada. This electrode is recommended best for all position stove pipe welding technique of steel pipes conforming to ASTM A 106Gr B, SA-283 (B,C,D) - A (P.No.1), API 5L X42-X56 grade materials(only DC+).

Alight coated, all position mild steel cellulosic electrode for fast freezing deposit in vertical up & down positions, especially at sites where out of position welding is necessary. It offers a deep penetrating forceful arc X-ray quality coarse ripple flat bead with very little slag. Usually drying of electrode is not required & it works well with high level of moisture in its flux covering.



CELWEL 70G & CELWEL 80G

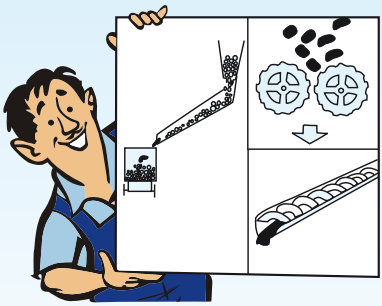
These electrodes are identical in characteristics to Celwel 60 and are appropriate for welding higher tensile strength of 70 & 80 ksi steels respectively. These electrodes are recommended for all position stove pipe welding technique of steel pipes conforming to ASTM / ASME specification SA-283 (B,C,D) - A(P.No 1), API 5L X 42,-X52 -X65 and -X70 grade steels (only DC+).

High Deposition efficiency electrodes are described in detail, along with benefits of higher productivity, in Chapter 4

2.4 Low Alloy & High Tensile Steel Electrodes

The popular electrodes in this range and their AWS / BIS classifications are:

Molyten	E 7018A1 / E 49B A1 26 Fe
Cromoten	E 8018 B2 / E 55 B B2 26 Fe
Cromoten C	E 9018 B3 / E 53 B B3 26 Fe
Cromoten D	E 8018 B6 / E 41 BB 626 Fe
Tenalloy 80HH (Spl)	E 11018M / E 76 BM 329 Fe
Ultracorten III	E 8018 W2



MOLYTEN

A low hydrogen, iron powder electrode for welding of ½ % Mo creep resistant steels used in pressure vessels, boilers & pipelines. It deposits X-ray quality weld metal, with easy slag removal (AC (70 V) DC +)

CROMOTEN

A low hydrogen iron powder electrode for welding of 1 ¼ % Cr ½ Mo steels used in refineries, power plants, etc. Weld metal is creep and heat resistant up to 550°C and is X-ray quality. The arc is very smooth and slag removal is easy [AC (70V)/DC +]

CROMOTEN C

A low hydrogen iron powder electrode for welding of 2 ¼ Cr- 0.50 Mo and 2 ¼ / Cr -1% Mo steels used in Refineries, Chemical Plants, Power Plants etc. Weld metal is creep and heat resistant upto 600°C and is X-ray quality. Very smooth arc and easy slag removal [AC(70V) / DC+]

CROMOTEN D

A low hydrogen iron powder electrode for welding of 5%Cr -½ Mo creep resistant steel for temperature up to 650°C. Weld metal is X-ray quality. Very smooth arc and easy slag removal [AC (70V) / D+]

TENALLOY 80HH (SPL.)

An extra low hydrogen, micro alloyed, iron powder electrode for welding of high tensile steels such as USS T 1 steel. An all position welder friendly electrode designed especially for fabrication of Penstocks [AC (70V)/DC +]

ULTRACORTEN III

A low hydrogen iron powder electrode for welding 0.6%Cr-0.6% Ni - 0.5% Cu low alloy steels, popular weathering steels such as Corten A and Corten B and their equivalents. Typical application is welding of CONCOR wagons [AC (70V)/ DC+].

All the above basic coated electrodes can be supplied in vacuum packing (R2U), on demand. The benefits of using these vacuum packed electrodes (R2U) are listed in Chapter 3.

Also available are many more electrodes that deposit weld metal with chemistry matching various types of low alloy steels, including rutile type of electrodes for root pass welding of chrome moly pipes.

2.5 Hard Facing Electrodes

The popular electrodes in this range are:

ZEDALLOY - 350
ZEDALLOY - 350 (LH)
ZEDALLOY - 550
ZEDALLOY - 550 (LH)
ZEDALLOY - 600
ZEDALLOY - K
MAGANACANE
ZEDALLOY - VB
ZEDALLOY -12 Mn
ZEDALLOY -16 Mn
ZEDALLOY - 20 Cr
SUPER - ZEDALLOY

The superior features of these electrodes are described below :

ZEDALLOY - 350 & ZEDALLOY - 350 (LH)

They are, respectively, medium heavy coated rutile-type & low- hydrogen type electrodes deposit air hardening weld-metal of typically **350 BHN** hardness, which can be machined with carbide tools, only. A buffer layer of TENALLOY16 or TENALLOY 16W is desirable on hard base metals. These electrodes are recommended for applications with metal to metal friction, mild impact & abrasion to reclaim the worn Conveyor parts, Cog wheels, Cams, Cold punching dies, Brake shoes, Drive sprockets, Track-links, Plough- shears, Shear-blades, etc. (AC / DC +)

ZEDALLOY - 550 & ZEDALLOY - 550 (LH)

These electrodes deposit air hardening type weld-metals of typically **550 BHN** hardness. Weld deposit is of a non-machinable alloyed white cast iron type, which can be shaped by grinding. A buffer layer of TENALLOY -16 W is desirable on hard base metals. The weld deposit is highly resistant to abrasion but not suitable for heavy impact. They are recommended for reclaiming oil expeller worms, Cone cutting knives, Bamboo chipper knives, Shear blades, Metal cutting & forming tools, Crushers and Conveyor parts (AC / DC)

ZEDALLOY - 600

An iron powder basic coated electrode that gives approximately **600 BHN** hardness on single layer weld. The weld deposit is extremely sound, hard and non-machinable. It enables you to deposit over High carbon high sulphur steels without giving underbead cracking or porosity. The weld deposit can be finished by grinding. It is best recommended for sugarcane cutting knives, Bamboo chipper knives, Paper cutting knives, Metal cutting & forming tools, Drilling bits, Shears, oil expeller worms, Mine Rails, Caterpillar treads, Conveyor parts, etc. (AC / DC+)

MAGANACANE

A super-heavy coated electrode specially developed for hard-facing of heavy loaded sugarcane crushing rollers for sugar mills. The electrodes strikes automatically even on wet mill rollers. It allows deposition of hemispherical dots on the rollstand also provides faster buildup due to high deposition rates. Thus imparts better grip to cane being crushed by the rolls & due to this efficiency & productivity of the sugar mills increases considerably.

ZEDALLOY - VB

A heavy coated basic electrode deposits an alloyed cast iron type weld, which is hard and extremely resistant to abrasion and metal to metal frictional wear. This is designed particularly to resist scratching wear and to occasional grinding abrasion such as caused by hard stone particles on oil expeller worms. It is recommended for oil expeller worms, Concrete mixer blade, Scrapper blades, Screw conveyors, Cement die rings, Muller tyres, Plough shears, Dippers, Excavator teeth etc. (AC / DC+)

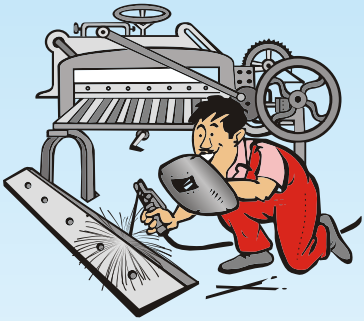
ZEDALLOY - 12 Mn

A medium heavy coated basic type non-magnetic austenitic 12% Mn steel electrode. Hardness of weld deposit, in as welded condition, is approximately **200 BHN** and increases by work hardening to Above **500 BHN** under the severe impact load in service. When using this electrode on mild steel or low alloy steel parts, a buffer layer of Betachorme N is recommended. It is ideal for surfacing worn out Dredger bucket teeth, Rock crushing jaw, Mn steel rail cross over & points, cement grinding rings, Austenitic Mn Steel castings, Crusher mantles, Hammers, etc. (AC / DC+)

ZEDALLOY - 20 Cr

A heavy coated electrode containing 17% to 20% Cr & 4% to 5% Ni with easy performance characteristics for hard overlays on carbon steels where resistance to combined effects of abrasion, impact and corrosion is necessary. The weld deposit is semi-austenitic and has a hardness of about **250 BHN** in as welded condition, which rises to **400 BHN** under heavy peening and further increases to **500 BHN** under heavy impact in service. It is popular in steel mills and recommended for dipper teeth, shovel tracks, Rock crushers, Crusher mantles, Coal mining cutters, Charging rams, Scrapper blades, Mill hammers, Drive sprockets, Dredger cutter teeth, Sand pumps, Impellers, Sacrificial teeth, Pulverizing hammers, Spinning tyres of mineral wool mill, hot-ingot lifting tongs, etc. (AC / DC+)

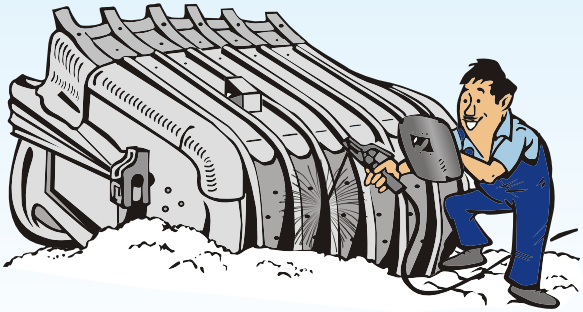
SUPER ZEDALLOY



An electrode to deposit weld metal having 35% Cr. and 3.5%C having **600 BHN** hardness, can be used wherever resistance to the most severe grinding abrasion and oxidation is required especially at elevated temperature of about 1000°C. Use only one or two layers to avoid cracking. Recommended Typical applications are coke chutes, Sand blasting equipments, Cement conveyor screws, Conveyors, grinding rings, Edge runner scrappers, parts of Earth moving & Mining equipments etc. (AC / DC+)

ZEDALLOY – K

A medium heavy coated electrode for hard facing depositing air hardening high speed steel / tool steel deposit typically with **600 BHN** hardness. Excellent for cutting tools, wood working tools, Shear blades, Hot punching & Shearing dies, Rolling mill guides, Ingot lifting tongs, etc. are the typical applications of this electrode (AC / DC +)



2.6 Stainless Steels & Heat Resisting Steel Electrodes

Superior Features of AWL Electrodes

The superior features of all AWL stainless steel electrodes are described below:

- Electrodes are easy to strike and restrike without any "Arc strikes" or cup formation
- Weld metal of all electrodes is of radiographic quality
- Low spatter loss, which is very important since stainless steel electrodes are expensive
- Weld beads are smooth, uniform and of excellent appearance
- All stainless steel electrodes are supplied in 300 mm length so that the occasional red hot tendency of stainless steel electrodes is eliminated, enabling the welder to use our stainless steel electrodes with barest minimum stub lost
- All stainless steel electrodes are packed in vacuum pouches so that they can be used immediately on opening, without redrying. The vacuum pouches contain 2 Kgs. of the stainless steel electrodes for convenient usage of the welder
- Electrodes are available for matching chemistry of various types of stainless steels

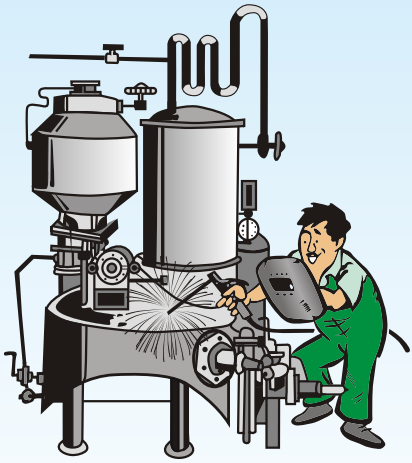
Welding Stainless Steels

When welding stainless steel it is important to know the grade of Stainless Steel, which is known by it's specification no. such as AISI 308, 316, 321, 347 etc.

SUPERINOX SERIES (AC / DC+)

Some of the popular electrodes which are generally used for joining stainless steels of various matching compositing are described below, along with their AWS / BIS classifications:

SUPERINOX - 1A (R2U)	E 308 -16 / E 19.9 R26
SUPERINOX - 3A (R2U)	E 308 -16 / E 19.9 R26
SUPERINOX - 1B (R2U)	E 347 -16 / E 19.9 Nb E26
SUPERINOX - 1C (R2U)	E 308L -16 / E 19.9 L R 26
SUPERINOX - 2A (R2U)	E 316 -16 / E 19.12.2 R26
SUPERINOX - 2B (R2U)	E 318 -16
SUPERINOX - 2C (R2U)	E 316 L -16 / E 19.12.2 R26



The suffix 16 after the AWS No., for e.g. 308-16, implies that they are all position electrodes suitable for AC / DC+(welding). All these stainless steel electrodes are also available in basic coated versions and will have a suffix 15 in the AWS code as well as the brand name, e.g. Superinox 1A-15 conforms to E 308-15 classification These electrodes are also all position but can be used only on DC+.

Superinox 1C 15 (LT) CONFORMING TO E 308 L -15 / E 19.9 LB 20 IS a basic coated 308L type electrode with controlled ferrite control specially designed for welding of similar stainless steel subjected to impact at -196°C.

Rutile coated electrodes have pleasing performance characteristics and are preferable for welding stainless steel plates up to 20 mm thickness. The basic coated electrodes give better mechanical properties at room and sub zero temperatures and can be used for welding thicker stainless steel plates.

BETANOX SERIES (AC / DC+)

Some of the electrodes used for joining dissimilar steels and for cladding applications are described below, along with the AWS / BIS classification :

BETANOX D (R2U)	E 309-16 / E 23.12 LR26
BETANOX D Mo (R2U)	E 309 Mo-16 / E 23.12.2 E26
BETANOX C	E 310-16 / E 25.20 R 26 X

For joining of carbon or low alloys steels to stainless steels, E309 / E309 Mo electrodes are recommended. Of course these electrodes are also used for welding matching composition steels. These electrodes are available in rutile and basic versions.

BETANOX PLUS SERIES (DC+)

The Betanox Plus Series of stainless steel electrodes deposit more weld metal, more concave fillet weld beads and are contact electrodes because of the design specifications. This category of electrodes is available for welding stainless steel of various compositions. The electrodes could be described as below:

BETANOX 308 PLUS (R2U) E 308-17 / E 19.9 R 26

BETANOX 316 PLUS (R2U) E 316-17 / E 19.12.2 R 26

And so on, depending on the AWS classification of stainless steel/ composition of the steel. The suffix 17 after the AWS No. eg. E308-17 indicates that the electrode characteristics are different. The slower freezing slag and a slight wearing technique ensures a concave bead with a larger leg size in fillet weaving.

These electrodes are available in rutile and basic versions.

BETACHROME SERIES (DC+)

Straight chrome steels are used in various applications such as valves, castings tubes or pipes having similar chrome content and two of the electrodes along with AWS specifications are described below:

BETACHROME 13 Cr E 410 - 15

BETACHROME 17 Cr E 430 - 15

These electrodes are also available with addition of 4% nickel i.e. 13 chrome, 4 nickle and 17 chrome 4 nickle type of electrodes are available for matching steels.

BETACHROME N conforms to E 18.8 Mn B45

For joining of Manganese steels to carbon steels and for producing crack free joints in difficult to weld high alloy steels as well as for depositing 18 Cr / 8 Ni / 5 Mn type of stainless steel. It is also used as a buffer layer for hardfacing applications, particularly while resurfacing Manganese components and others (AC/ DC +)

Range of Stainless Steel Electrodes

Electrodes for welding all types of stainless steels, (including Duplex and super Duplex) and applications are available. Please refer to our weld directory for a complete listing of stainless steel electrodes.

2.7 Duplex & Super Duplex Stainless Steel

BETANOX 4462 (E2209-16)

An electrode depositing Austenitic-Ferritic weld metal suitable for welding of duplex weld metal having uniform & fine ripples. Slag removal is very easy & spatter loss is extremely low. Used for piping in Gas & Oil Industry, Off shore platforms.

BETANOX 2594 (E2594-15)

Electrodes provide matching chemistry and mechanical property characteristics to wrought super duplex alloys as well as super duplex casting alloys. Weld metal gives high resistance to chloride induced stress corrosion cracking and pitting attack in chloride environment, e.g. sea water. Welding of super duplex stainless steels such as SFA 2507 and Zeron 100 as well as super duplex casting alloys, e.g. ASTM A890.

BETANOX 2595-15 (E2595-15)

A basic coated electrode depositing austenitic ferritic weld metal suitable for welding of super duplex stainless steels. Presence of Tungsten in weld metal retards the formation of inter-metallic compounds in the HAZ and thereby increases resistance to hot cracking. Welding of super duplex stainless steels such as UNS S32550, S 32750, S 32760 (wrought) and UNS J93370, J93380, J93404, CD4MCuN (cast).

BETANOX 2595-16 (E2595-16)

A basic coated electrode depositing austenitic ferritic weld metal suitable for welding of super duplex stainless steels. Nitrogen and Nickel contents in the weld metal are controlled to produce a balance duplex structure to ensure good toughness and freedom from weld cracking in highly restrained joints. Used to weld standard duplex stainless steel such as UNS S31803 and UNS S 32205 and for the welding of carbon and low alloy steels to duplex steels as well.

2.8 Electrodes for Welding Non- Ferrous Alloys

The superior features of electrodes for some copper alloys and their AWS specifications are as follows:

SUPERMONEL (ENiCu-7)

A medium-heavy, basic coated Monel electrode depositing low iron content in the weld deposit for maximum corrosion resistance. The weld metal chemistry is so adjusted that the deposit will not harden when weldments are heat treated. The welds are of radiographic quality. Used for welding Monel to itself, to stainless or carbon steels and for overlaying on steel to obtain a corrosion resistant surface. (DC+)

BRONZE (ECuSn-A)

A low hydrogen type electrode for welding copper and bronze as well as copper or bronze to steel. The core wire is made of phosphor bronze. Also suitable for welding cast iron with some degree of preheating to get machinable welds, where colour matching is not demanded. (DC +)

Please refer to the AWL weld Directory for electrodes for welding of aluminum and Nickle Alloys.

2.9 Electrodes for Welding Cast Iron

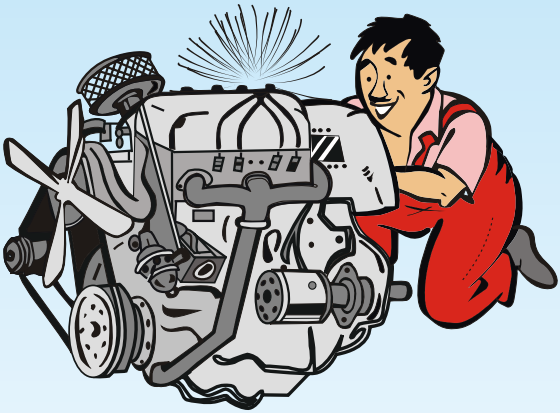
Cast iron is a difficult to weld metal. The use of electrodes described as follows, will make welding of cast iron easier.

CASTEN (E St)

Low-hydrogen, low-carbon, steel electrode to give strong, non-machinable joints on cast iron. It is very necessary to preheat the base metal to 550° C for complete success. (AC / DC +)

CASTMONEL (R2U) (ENiCu-B)

An electrode with Monel core and graphite-based coating for welding cast iron without much preheating and for obtaining a machinable weld deposit of hardness **< 200 BHN**. This is designed to produce a soft arc with shallow penetration but sufficient to ensure minimum dilution from the parent metal. You the



welder, will bear in mind that the electrode while tracking the arc will always be kept within the weld puddle but not ahead to ensure minimum dilution from cast iron to steels, repairing & rebuilding cast iron castings, gears, pump bodies, etc. (AC / DC +)

CASTNICKEL (R2U) (ENi- CI)

An electrode with pure nickel core wire specially designed for welding cast iron in the cold way. The nickel deposit does not pick up carbon from the base metal and hence remains ductile, soft, easily Machinable and at the same time retains adequate strength. This enables successful use of the electrode without the necessity of preheating even on large complicated cast iron parts. (AC / DC +)

FERRICAST (R2U) (ENiFe-CI)

An electrode especially designed with ferro-nickel core wire to weld cast iron in the cold way. The nickel-iron deposit does not pick up carbon from the cast iron base metal and hence remains ductile, soft and easily machinable, while retaining adequate strength. This permits successful use of the electrode without the necessity of preheating even on large complicated castings. It is recommended to weld S.G. OR Nodular cast iron, mild steel to cast iron, repair, building & correcting errors of machined cast iron parts (AC / DC +)

CHAPTER 3

LOW HYDROGEN (BASIC COATED) ELECTRODES

3.1 Precautions to be taken while using Basic Coated Electrodes

Hydrogen controlled or low hydrogen electrodes are baked at 400-450°C during manufacturing to remove the last traces of moisture from the flux covering so that they do not release hydrogen in the arc. Hydrogen is harmless in normal mild steel thickness < 25mm butt joints but causes "under-bead cracking" on thick parts of mild steel, on medium & high carbon steels © >0.30%) and on low alloy high tensile strength steels. Hydrogen also causes porosity on high-sulphur steels.

When basic coated electrodes are used for large structural welding or for welding steels with a high carbon equivalent, the fabricators need to take precaution against increasing hydrogen level in the electrodes to prevent cold cracking in the joints.

Some of these precautions are :

- Storing the electrode cartons in a controlled temperature / atmospheric place (preferably 10° C-15° C Warmer than outside temperature and RH at less than 35 to 40)
- Drying the electrodes before use, in an oven and hold in a quiver at point of consumption (300° C for 1 hour)
- Re-baking electrodes in case they have absorbed excess moisture due to over exposure (400°C for 2 hours)

At times even preheat the steel (please refer to chapter 4).

Lack of these precautions lead to further increased costs due to weld defect repairs (porosity, high spatter & smoke levels) and reduced welder's productivity.

These precautions are needed even for electrodes with very low hydrogen content in the coating, since moisture pick up during storage and an exposure to atmosphere can offset the benefits of using these electrodes.

3.2 Advantages of Vacuum Packaging (R2U)

- Ador Welding Limited has introduced the vacuum packed (R2U) packing for basic coated electrodes. R2U packed or vacuum packed electrodes are basic coated electrodes packed on a state-of-the-art automatic line where vacuum packs are made under controlled conditions to retain as manufactured properties
- R2U packed electrodes enable welders complete their work without re-drying the electrodes. Labels are provided with the packs for welders to record details of time electrodes received, so they are able to keep a track of the hours for which the opened electrodes are exposed to atmosphere
- Since electrodes can be opened and used directly without re-drying, the welder's time is saved, leading to higher productivity
- Reduce or eliminate steel preheating for the same reason as above
- Saving on electricity since the electrodes are not re-dried
- Reduce or eliminate steel preheating for the same reason as above
- Electrodes that have been exposed to the open environment for over 8 hours, require re-drying at 300°C for 1 hour
- Packed in multi-layers of plastic and Aluminium foil, hence punctures are prevented
- Convenient 2 kg. pack
- Optional Graphite tipping available for easier arc strike
- Ready-to-use for welding in any climatic conditions

CHAPTER 4

PRODUCTIVITY WITH SMAW / MMAW ELECTRODES

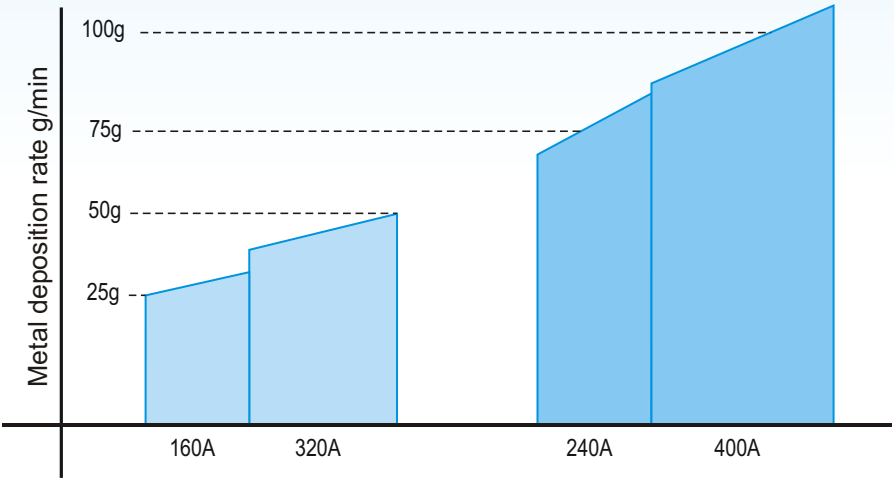
Productivity can be increased while welding with stick electrodes by :

a) Using high deposition efficiency electrodes
b) Ensuring there is minium or no rework by following proper welding procedures
c) Taking safety precautions so there is no downtime

4.1 High Deposition Efficiency Electrodes

Deposition Efficiency

"Deposition Efficiency" of an electrode indicates the amount of weld metal obtained for every 100 grams of core wire of the electrode melted in the arc. SUPERBOND has approx. 90% deposition efficiency. This means that for every 100 grams of the electrode wire melted, you get 90 grams of weld metal. The rest is lost by spatter, evaporation and metal slag reaction. Deposition efficiency is thus a true measure of the economics of an electrode. A lower priced electrode with very low deposition efficiency will often be found to be more uneconomical than a higher priced electrode with high deposition efficiency.



High Deposition Mild Steel Electrodes

In the mild steel range, the deposition efficiency is increased beyond 100% by adding iron powder to the coating. Therefore, electrodes giving more than 100% deposition efficiency are called “iron powder" electrodes. There are four iron powder electrodes in our mild steel range of electrodes:

Electrode	Deposit Efficiency
SUPABASE X PLUS	115%
SUPABASE 180	180%
TOPSTAR 110	110%
TOPSTAR 140	140%
TOPSTAR 210	210%

Iron powder electrodes can take higher currents and melt faster without causing undercut. Compare TOPSTAR 110 with, SUPERBOND in the same welding time, TOPSTAR 110 will deposit 20% more weld metal than SUPERBOND. Thus by changing over to the iron powder type your shop can increase output by 20% without going in for additional welders and welding machines.

Iron powder electrodes can be used as “contact” electrodes and manipulated without much effort. The slag removal is excellent and the weld metal is extremely strong and ductile.

The level of smoke generated / gm of weld deposit is much less compared to any non iron powder type electrode.

Please therefore check the deposition efficiency of all electrodes in your shop floor.

High Deposition Low Alloy Electrodes

When you come to alloy steel electrodes the high deposition efficiency is due to iron powder plus alloying powders which go into the coating. Examples are given below :

Electrode	Deposit Efficiency
TENALLOY Z PLUS	112 %
MOLYTEN	106%
CROMOTEN	108%
CROMOTEN C	106%
CROMOTEN D	103%

High Deposition Hard Facing Electrodes

Hardfacing electrodes also have over 100% deposit efficiency because of alloys derived from the coating Synthetic electrodes like ZEDALLOY 12 Mn, SUPERZED ALLOY, BETACHROME N etc. which are based on mild steel core wire have high deposition efficiencies because of the alloys and iron powder in the coating. For example, BETACHROME N has 135% deposit efficiency.

In all these electrodes, you must check the welding current by means of a tong ammeter because the actual current is about 20% less than what is indicated on the scale. This is because these electrodes give very high arc voltage, while the scale is based or ordinary electrodes. To be on the safer side, set the current 15% higher. In other words, if you keep the setting at 230 amp, you may expect an actual current of 200 amp. With iron powder electrodes.

4.2 Proper Welding procedures for ensuring minimum or no rework

Preheating & Inter Pass Temperature Maintenance

The preheat temperature is the minimum temperature of the steel to be welded, at which your arc must begin and the inter-pass temperature described is the maximum temperature, which must never be allowed to exceed while welding. The preheat temperature is a significant variable for controlling the restraint crack, under bead crack and also the level of diffusible hydrogen in HAZ. The inter-pass temperature maintenance enables you to obtain a fine grain structure & thus the best weld-metal impact strength at subzero temperatures in high strength low alloy steels. Please refer to the table on following page for preheating temperature to be maintained while welding thick sections of different steels with low hydrogen and rutile electrodes.

Schedule Of Preheating Temperatures of Different steels, When Welding with Low Hydrogen Electrodes and Rutile Electrodes

Steel	Thickness	Minimum preheating Temperature°C	
		LH Electrode	Rutile Electrode
Mild Steel 52 kg/mm^2 UTS Max.	Up to 20 mm	NIL	NIL
	20mm to 50mm	NIL	150°C
High Tensile Steel 52-62 kg/mm^2 UTS	Up to 20 mm	NIL	150°C
	20mm to 50mm	100°C	Should not be used
T1 Steel	Up to 30 mm	120°C(max)	Should not be used
	>30 mm	Consult Manuf.	Should not be used
½ Mo steel	Up to 30 mm	NIL	150°C
	20mm to 50mm	100°C	Should not be used

Steel	Thickness	Minimum preheating Temperature° C	
		LH Electrode	Rutile Electrode
1 Cr-1/2 Mo steel	Up to 20 mm	100°C	150°C
	20mm to 50mm	100°C	Should not be used
2 ¼ Cr-1 Mo steel	Up to 50 mm	200°C	Should not be used
5 Cr- 1/2 Mo steel	Up to 50 mm	300°C	Should not be used

Avoiding Preheating

There are other extremes which have to be observed while welding austenitic stainless steel, work hardening austenitic manganese or Hadfield steels. Their low thermal conductivity property permits the accumulation of localized heat in HAZ, which causes weld decay, stress corrosion cracks in corrosion resistant stainless steels & instant cracks in work hardening type austenitic manganese steels. Thus they must never be preheated. They must be allowed to cool faster by using chilled copper bars or even chilled water circulating around the substrate to ensure the maintenance of minimal inter pass temperature of 200°C maximum for stainless steel or as low as even 55°C maximum inter-pass temperature for austenitic manganese steel component parts.

4.3 Weld Defects and Procedures to minimize them

The weld defects described below can be avoided by following the right procedure.

Arc Blow

This type of problem appears only while welding with DC power source in which an arc becomes uncontrollable and electrode end burns taper and resembles an eccentrically coated electrode. To overcome arc blow problem in DC arc welding the following corrective steps may be taken :

1. Current may be slightly reduced.
2. Weld towards a heavy tack weld or the weld bead already made
3. Use back-step welding technique on long seam joints.
4. Place ground connection closer to the arc position.
5. Wrap the ground cable around the job to neutralize the effect of magnetic arc blow.

Switching over to AC arc may be the final & last option for some typical job design.

Cracks

The remedies suggested for cracks caused by the following, alone or in combination, are:

1. Weld metal is not ductile enough; it may be too low in manganese or too high in carbon. Change over to correct electrode.

2. Base metal is high in carbon or sulphur or contains hardening elements like Mo, Cr, V, Ni, etc. Change the base metal or use low- hydrogen electrodes and preheat, if necessary.
3. Base metal is too thick or the assembly is under very heavy restraint. Use preheat and correct welding sequence.

4. Electrodes are very damp. Dry the electrodes as per recommendations.
5. In high carbon steels and alloy steels, especially when the sections are thick, “under-bead cracks” are found at the junction between the weld metal and the base metal. They are invisible and open out to the surface after sometime. They can be avoided by using low-hydrogen electrodes freshly dried in an oven and preheating the joint areas adequately.

Lack of Fusion

This defect is caused by incorrect joint preparation & fit-up, use of too small or too large an electrode in relation to the joint size, improper arrangements of weld passes, too low welding current forgiven size of electrode.

Overlapping

Overlapping is caused by using too little welding current & too slow travel speed of welding. Also due to incorrect electrode angle & weaving technique. The thermal co-efficient of expansion of the steels and its volume and directly proportional to the level of residual stresses and distortion. Planning correct welding sequence is absolutely essential for managing distortion in any fabrication, big or small.

Porosity

May be seen over the surface or may be hidden inside the weld. Caused by damp electrodes, rusty or dirty plates, high sulphur in the plate or pipe materials or sluggishness of the weld puddle. If the weld is sluggish, increase the welding current and weave electrode briskly. Cluster porosity indicates the need of changing your arc striking technique from tapping to scratching type. Linear porosity appearing longitudinally in the middle of weld bead is a sign of lack of penetration and if it is observed at the toe then that is a sign of lack of fusion or overlapping. Damp electrodes, Particularly low hydrogen electrodes need to be redried and use Supabase X- Plus electrodes to achieve porosity free welds.

Slag Inclusion

It may be on the surface or hidden. It is caused by the dirty & uneven fusion faces, inadequate cleaning after each pass, improper arrangements of passes. Too convex bead, too large size of an electrode applied in a narrow groove will also contribute to slag inclusion. Improper electrode angle, unstable long arc too invite the problem of slag inclusion.

Under Cut

It is caused by using too high welding current and too fast speed of travel. It is also caused by the incorrect weaving technique & electrode angle.

Stray Flash ' ARC Strike'

It is caused by using a wrong practice of aimless arc striking hither & thither beyond the groove of the butt or fillet joint. This is considered to be a serious nature defect particularly while welding high strength steels or stainless steels. This causes hard & brittle spots, micro-fissures, cracks, corrosion or also deterioration in aesthetics of the job. This type of defect has been found to be highly detrimental for several important structures where heat treated high strength quenched & tempered steels or stainless steels had been used.

Defects in Butt Welds

The main defect is lack of root penetration, Which is caused because the root is not gouged out adequately before welding from the second side.

Defects in Fillet Welds

Main defects are lack of root penetration, unequal leg lengths, too much convexity and undercutting at the toes.

Lack of root penetration can be avoided by using a higher diameter electrode with adequate current wrong electrode angle causes unequal leg lengths. To avoid undercut don't use too high current and too fast welding.

4.4 Welding Sequence & Control of Distortion

How Distortion Occurs

Weld metals are subjected to a great load of contraction when they cool. Enormous shrinkage forces are generated, thereby causing the development of massive residual stresses & in turn, avoidable distortion. The thermal co-efficient of expansion of the steels and its volume and directly proportional to the level of residual stresses and distortion. Planning correct welding sequence is absolutely essential for managing distortion in any fabrication, big or small.

Managing Distortion

The three golden rules to be followed for managing distortion are:

1. **Reduce the cause of shrinkage forces to minimize distortion.**

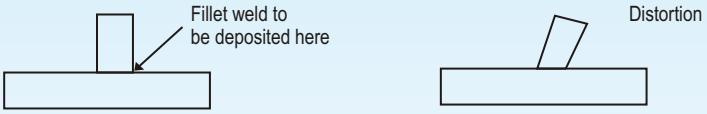
   Since weld metal is itself the prime cause of shrinkage, distortion can be minimized by (a) judiciously designing the weld geometry and joint preparation so that minimum weld metal needs to be

deposited (b) depositing the weld metal in a minimum no. of passes by using largest size permissible electrodes / iron powder electrodes /MIG & SAW processes.

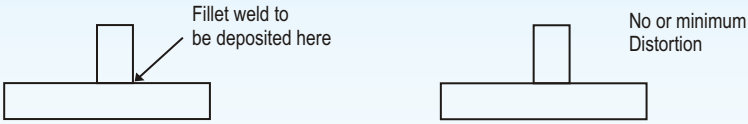
Preheating of the plates to be welded also helps in managing distortion by reducing the quantum of residual stresses.

2. **Make use of shrinkage forces to minimize distortion.**

This sounds very simple and calls mainly for the presetting of joints to allow for shrinkage. This requires a great deal of experience and a number of exercises have to be carried out, including at the design stage, before a final meaningful decision about the degree or level of pre setting can be made. A typical pre setting example is shown below:



(Distortion in a fillet weld without pre-setting, due to shrinkage)



(Fillet weld in which presetting has been planned)

This presetting varies from job to job, from welder to welder and from shop floor to shop floor. When correct pre-setting is achieved, the metallurgical properties of the weld metal will be the best because the weld metal will be free from the locked up resident stresses.

3. **Balance the shrinkage forces to minimize distortion**

The third rule for minimizing the distortion is followed almost by everyone. In this category the shrinkage forces are literally balanced either by (a) sequencing the weld beads by laying in back-step (b) using intermittent welding techniques (c) by using external forces i.e clamps, jigs & fixtures or a combination of these to minimize distortion.

4.5 Hints for ensuring Radiographic Quality Welds

1. Select the electrode type which has been approved by the established welding procedure or the WPS for the radiographic quality welding.
2. Select basic coated electrodes which are ready to use (R2U) or re-dry the electrodes

In electrode drying oven at temperatures recommended by the manufacturer.

3. Use DC. If AC to be used, make sure that there are no fluctuations in the primary supply line of welding transformers and they have a minimum required OCV for the electrode.
4. Ensure that the joints are correctly prepared & fitted-up accurately.
5. Ensure that the joint surfaces are free discontinuities, dust, grease, moisture, oil, Paint & rust.
6. Lay sound and well fused tack welds. Badly made tack welds must be chipped out.
7. Lay each pass methodically & skillfully so that the weld fuses well without undercut or overlap. Remove the slag thoroughly, if required, by using even pneumatic tools.
8. Do not make weld bead too convex; pause at the end, while weaving.
9. Examine the craters carefully and, if required, grind or chip out the defective or badly filled craters.
10. Examine each weld pass visually, by using even magnifying glass (if required) for porosity, slag inclusions or cracks. If any suspected discontinuity is observed then remove immediately either by chipping or grinding to rectify.

11. Do not use excessively high current or too high welding speed to hurry up with the job.
12. In making a butt weld joint, make sure that back gouging is done sufficiently deep inside up to the sound metal surface on the other side.
13. At site welding, shield the welding area from strong breeze and rain.
14. Please note that repairing after completing the entire weld joint will be too expensive.
15. We assist and train welders for all position x-ray quality welding, including selection of the correct electrode for different applications. Please call for prospectus & training schedule from our centre for welding excellence. Welders capable of making radiographic quality welding in all positions are considered ACE welders.

4.6 Safety Rules for Manual Metal Arc Welding

Safety rules of SMAW process to be commonly observed are given below :

- Never touch with your bare-hands the non-insulated part of the welding cables, cables connectors, clamps, electrode-holders, electrodes or the primary side of the power supply equipment to prevent fatal electric shock or burns

- Never work in damp area without suitable insulation against shock. Keep your hands, feet and clothing dry at all the times
- Never leave an un-insulated electrode holder or live electrode on the table top or in contact with ground metallic surfaces
- Switch-off your welding equipment before you leave the workplace
- Do not over load the cables and refrain from using worn-out or poorly connected cables
- Do wear tightly-laced safety shoes and leather hand gloves to protect you from electric shock & Injuries

Radiation, Burns & Injuries

Arc Eyes

Ultraviolet and infrared radiation is produced by the electric arc. Ultraviolet radiation

Can cause painful eye injuries to the unprotected eyes. Such burns, frequently referred

To as "arc-eye or flashes" feel like hot sand particles are in eyes. If the eye is focused on the arc without proper protection (the recommended choice of dark filter glasses are 10, 11 or 12 called as shade numbers), infrared radiation can cause retinal scarring and impaired vision. For eye burns, do get immediate medical attention.

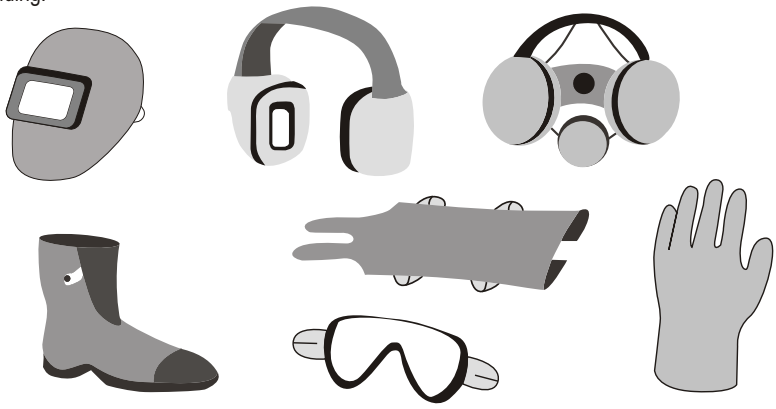
Do not use cracked, ill-fitted or defective filter glasses. Replace the defective filter glasses promptly and never use them without sandwiching them between two clean cover glasses, since air circulation keeps the filter glass cool and comfortable for the welder. Frequent replacement of cover glasses may be necessary, if they are covered with spatters or there is reduced vision due to any other reason.

Replace cracked or defective helmets or face-shields since leakage of arc rays may cause serious burns.

Burns Because of clothing

Your clothing, which protects the body from radiation & flying hot spatters, should be properly buttoned to protect the body fully from radiation and burn hazards. Clothing shall be of fire resistant type.

Leather-gloves, hand sleeves, aprons, leg guards too are used to protect your body from radiation & burn injuries, caused by radiation, flying-spatters and hot slag particles, particularly while doing positional welding.



Other Injuries

Injuries too may also be caused by ignoring rules of good housekeeping, not using a face-shield while grinding, protective helmets, hooks & belts while working at heights on shop/site

Ventilation & Exhaust

Do not weld in confined spaces without opening doors, windows, ventilators or using a local exhaust / ventilation system. Do not position your head against the fumes & smoke stream emitted from your arc welding operation, which may cause discomfort, illness or serious personal injury, if the harmful concentration of fumes & smoke is allowed to get accumulated in your work area.

Provide local exhaust ventilation blowers, compressed air, air mask, as needed, to prevent harmful accumulation.

Welding contaminated base-metal surfaces such as - beryllium, cadmium, lead, paint, mercury and zinc and others need special care and adequate ventilation before striking an arc

Fire & Explosion

The slag & sparks produced by shielded metal Arc welding (SMAW) process will cause an indiscriminate fire if allowed to come in contact with combustibles. Keep the combustible materials at least 10 to 12 meters away from your welding operation. If the welding operation. If the welding operation can't be relocated for some reason then protect the combustible materials against ignition by covering them fully with the use of fire resistant cover or screens.

Do develop a good habit of surveying the area of your welding operation before & after completion of welding.

Never strike an arc over any empty or closed chemically- contaminated containers or near area where an explosive atmosphere exists. Such atmospheres may be created by flammable gas leaks or by vapors from inflammable liquids like alcohol, gasoline, etc. or by combustible dusts. An empty container's lid must always be kept open, washed, purged or partially filled with water, if required, before you strike an arc over the surface.

Seek "**HOT WORK**" permit from your superiors for non-routine welding operations.

Mark the job **"HOT**" before you leave the place of your welding.

Noise

Disagreeable level of noise is frequently referred to as noise pollution. The high level of noise pollution causes problems such as loss of hearing, sleeplessness, loss of concentration, tiring-fatigue, uneasiness, irritation etc. Shielded metal arc welding as a process does not produce noise pollution beyond a moderate level and that too by the motor or engine driven generators; however, the welders work under diverse areas of industry and may face the problem of noise pollution due to allied trades like chipping, grinding or other related activities. Using earplugs or ear-muffs is the right choice to protect the ears.

CHAPTER 5

GAS METAL ARC WELDING (GMAW)

5.1 Solid Wires For Co_2 Welding

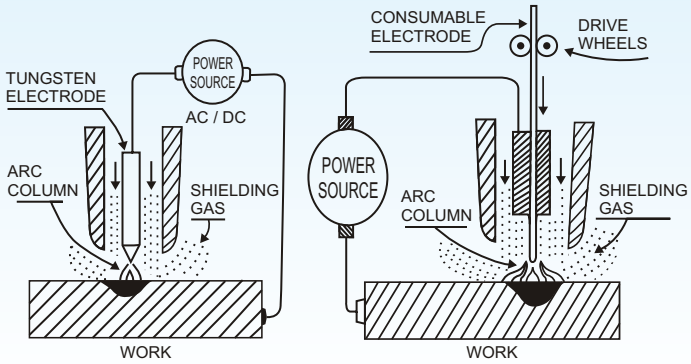
The AWL range of solid wires includes wires for TIG welding of mild / carbon steels, corrosion resistant steels and stainless steels.

Solid Wires For Welding Mild / Carbon Steels & Corrosion Resistant Steels

The superior features of some of the wires and their AWS / BIS specifications, are described below :

AUTOMIG 70S – 6 ER 70S-6 / S4 C504

AUTOMIG 90S D2 ER 90S D2



Automig 70S-6

This is a copper coated wire for CO_2 welding mild and carbon steels. Uniform copper coating as well as optimum helix and cast ensure smooth feeding and stable arc with minimum spatter. The wire is suitable for welding sheets/plates where dirt, rust or mill scale is present. Normally recommended with CO_2 shielding but when used with Argon+CO_2 mixtures, the weld deposit has improved mechanical properties. (DC+)

The wire is supplied in plastic spools of 15 Kgs. and $MIGPAC_S$ of 100 Kgs. and 250 Kgs.

Automig 90SD2

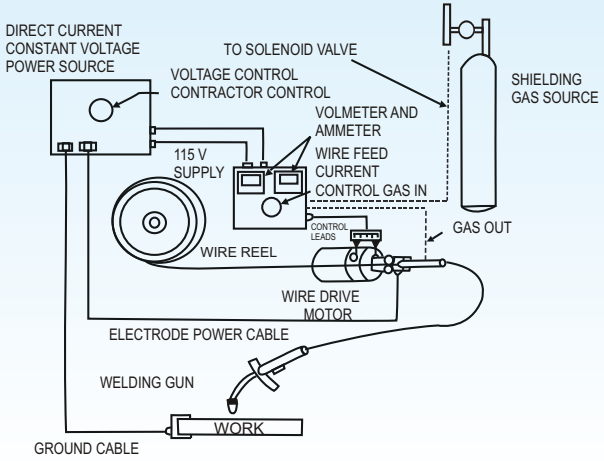
This is also a copper coated wire with similar superior features and packaging as Automig 70S-6. This wire is used for welding of high tensile steels as well as for corrosion resistant steels such as those used for fabricating Concur wagons.(DC+)

Solid Wires For Stainless Steel Welding

The following popular grade of stainless steel wires conforming to the respective AWS classification are available for MIG welding of stainless steels.

AUTOMIG-308	ER 308
AUTOMIG-308L	ER 308L
AUTOMIG-347	ER 347
AUTOMIG-316	ER 316
AUTOMIG-316L	ER 316 L
AUTOMIG-309	ER 309

Depending on the type of stainless steel being welded, the appropriate stainless steel wire is selected. These wires are available in 15 Kg plastic spools & to be used only with Argon gas shielding.



5.2 Flux-Cored Wires for CO_2 Welding

The AWL range of flux-cored wires includes wires for welding of mild / carbon steels, low alloy steels, special steels / applications and stainless steels.

Flux-cored wires for Welding mild / Carbon steels

The superior features of two popular flux-cored wires in the range are described below along with their AWS classifications.

AUTOMIG FC 71T1 (E71T1)

AUTOMIG FC 71T1

This is an all position rutile based flux-cored wire. The weld metal deposited is higher than with solid wires. There is very low spatter and slag detachability is excellent, depositing a shining weld bead. The Shielding gas is CO_2 and the typical applications include welding of mild steels and carbon steels used for general fabrication.(DC+)

Flux-Cored Wires for welding Low Alloy Steel

Flux cored wires are available for welding of low alloy steels such as ½ moly, 1 chrome ½ moly and 2 ¼ chrome 1 moly. The superior features of these wires along with the AWS classifications are described below :

AUTOMIG FC 81T1-B2	E81T1-B2
AUTOMIG FC 91T1-B3	E91T1-B3
AUTOMIG FC 81T1-Ni1	E81T1-Ni1
AUTOMIG FC 18M Spl	91T1-D1

AUTOMIG FC 81T1-B2

A folded flux-cored wire containing rutile flux, producing radiographic quality sound weld with good arc stability & easy slag detachability. Best recommended for joining of 1Cr-1/2 Mo & similar composition creep resistant steels

AUTOMIG FC 91T1-B3

It is a low alloy basic type folded flux-cored wire with CO_2 gas shielding. Low spatter, easy slag removal, uniform weld bead giving radiographic sound weld. Applicable for fine grained structural steels like NA-XTRA 55, NA-XTRA 60, WB-35, BHW-33, BHW-38. Current type (DC+) & 100%CO_2

AUTOMIG FC 81T1-Ni1

These are specially designed to produce weld metal with improved impact properties. Welding can be carried out at relatively higher welding current, higher deposition rates are obtainable. Welding of A203, Class 1 or 2, grade E & HY-80, Offshore fabrication & Structural steel work. Current type (DC+) & 100% Argon or Argon + Co_2

AUTOMIG FC 18M Spl

These are specially designed to produce weld metal having high tensile with moderate impact toughness. It is rutile type flux cored wire with stable and smooth arc, easily removable slag, less spatter and fumes. Wisely used for welding of High Tensile Steels like IS 8500 Gr. 540B, 570B and 590B; IS 2002 Gr.III; IS 1875 CL IIIA. Welding of SAILMA 450/450HI steel used in CONCOR wagons is a typical application for this wire.

Flux-cored wires for welding special steels / Applications

These flux-cored wires along with the AWS specifications are described below :

AUTOMIG FC 90 T5-K2	E 90 T5-k2
AUTOMIG FC 110 T5-K4	E11 T5 K4

Automig FC 90 T5-K2

This flux-cored wire is used for welding medium high tensile structural steels and heavy sections subject to impact at up to -51°C .The superior features of this flux-cored wire are similar to the features of the flux-cored wires described above.(DC+)

Automig FC 110 T5-K4

This is low alloy flux-cored wire suitable for welding high tensile, quenched and tempered steels. The impact properties at -51°C are excellent. This wire has all the superior features of the flux-cored wires described above.(DC+)

5.3 Productivity with MIG / MAG Welding Wires

Depositing more quantity of weld metal per shift without increased fatigue, by individual welders is easily achieved by switching over to the MIG welding process. The advantages of this process are as follows :

- Increase in weld metal deposition rate
- Increase in depth of penetration into the base metal
- Increase in continuous arcing

Increase in Weld Metal Deposition Rate

The weld metal deposition rate, in unit of kg /arc hour, is measured by the amount of weld metal deposited at given current level. In single pass or single pass per side welds, the welding speed per Meter of joint increases with the MIG process. Likewise, in multi-pass welds, the number of passes required to complete the joint decrease considerably and the time to complete the joint reduces.

To illustrate, let us compare the deposition rate of the MMAW to the MIG process:

- The deposition rate for 5.0 mm, MMAW E 7018 electrode at 220 amps is 2.1 kgs / arc hour
- The deposition rate for 1.2 mm, MIG wire (ER70S-6) at 250 amps is 4.2 kg / arc hour.

Depth of penetration into the Base Metal

The depth of penetration, in mm, is measured by the depth of fusion on unprepared surface, at a given current level and a given welding speed. Higher the depth of penetration, lesser is the need for joint preparation or back gouging. Multiple pass welds can be reduced to single pass or single pass per side welds, with less or no joint preparation or back gouging. Thus the joints can be completed faster. Let us compare the depth of penetration of the MMAW & MIG process.

- The depth of penetration for 5.0mm E 7018 electrode at 220 amps is 2 mm
- The depth of penetration for 1.2mm, MIG wire (ER 70S6) at 250 amps is 3.5 mm

Increase in Continuous Arcing

In MMAW process the welder has to stop welding to take a new electrode. This interruption reduces the useful time of the welder to be used for arcing duty and weld metal deposition. In MIG welding, since the wire is fed continuously, the arcing duty increases without increasing fatigue. Thus more weld metal can be deposited per welder.

Let us compare the arcing duty of the MMAW process with the MIG welding process.

- The arcing duty possible with a manual 5.0 mm E 7018 electrode could be 25%
- The arcing duty possible with a 1.2 mm MIG wire ER 70S6 could be 30%

From the above examples, it is possible to understand the high productivity that can be achieved by using the GMAW process.

CHAPTER 6

TUNGSTEN INTERT GAS (TIG) WELDING WIRES

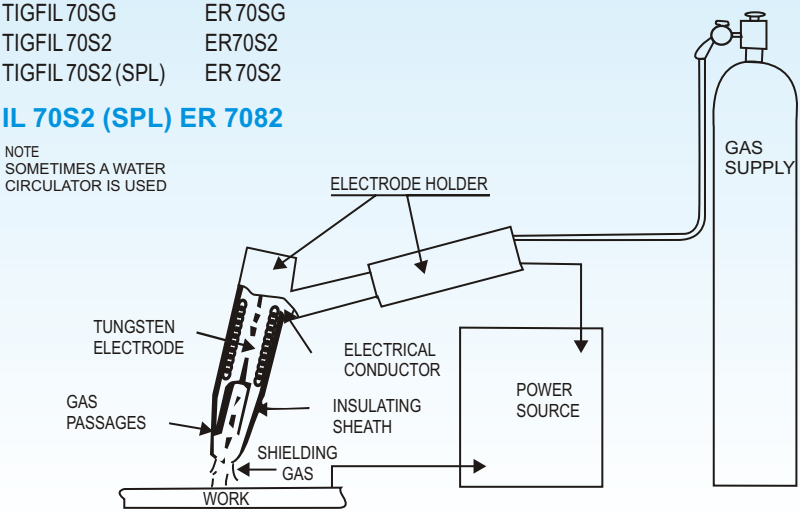
AWL range of wires for TIG Welding are available for welding mild/ carbon steels, low alloy chrome moly steels and stainless steels.

Wires for TIG welding of Mild & Carbon Steels

Some of the wires for TIG welding of mild TIG and Carbon steels along with their superior features and classifications are described below :

TIGFIL 70SG	ER 70SG
TIGFIL 70S2	ER70S2
TIGFIL 70S2 (SPL)	ER 70S2

IL 70S2 (SPL) ER 7082



SCHEMATIC DIAGRAM OF TIG WELDING

TIGFIL 70SG

This is suitable for welding all steels subjected to applications at 0°C. A copper coated wire with specifications of chemistry and properties conforming to ER70SG requirements. The brand name is embossed on the end of the wires which are packed in 1 mtr. lengths.

TIGFIL 70S2

This is a copper coated wire with similar features to that of TIGFIL 70SG and is suitable for applications at -29°C and conforms to ER70S2.

TIGFIL 70S2 (SPL)

This wire, also conforming to ER 70SR, is suitable for application at -46°C and can be used for NACE application. It has similar superior features to the wires described earlier.

Wires for TIG Welding of low Alloy Chrome Moly Steels

Some of the wires suitable for TIG welding of low alloy chrome moly steels are described below along with their superior features and AWS classifications :

TIGFIL 70SA1	ER70SA1
TIGFIL 80SB2	ER80SB2
TIGFIL 90SB3	ER90SB3
TIGFIL 80SB6	ER80SB6
TIGFIL 90SB9	ER90SB9

TIGFIL 70SA1

This is a copper coated wire suitable for welding of ½ moly steels and conforms to ER 70SA1.

TIGFIL 80SB2

This wire is suitable for welding 1 chrome ½ moly steels and conforms to the classification ER 80SB2.

TIGFIL 90SB3

This wire is suitable for welding 2 ¼ chrome 1 moly steels and conforms to ER 90SB3.

TIGFIL 80SB6

This wire is suitable for welding 5 chrome 1 moly steels and conforms to ER 80SB6.

TIGFIL 90SB9

This wire is suitable for welding 9 chrome, 1 moly steels and conforms to ER 90SB9.

Wires for TIG Welding of Stainless Steel

Some of the wires for TIG welding stainless steel are described below along with their superior features and AWS classification:

TIGINOX 308	ER 308
TIGINOX 308L	ER 308L
TIGINOX 347	ER 347
TIGINOX 316	ER 316
TIGINOX 316L	ER 316L
TIGINOX 309	ER 309
TIGINOX 309L	ER 309L

Depending on the stainless steel that is being welded, appropriate TIGINOX grade of wire is used e.g., for welding of 308 steels, TIGINOX 308 wire is used & so on. Also for welding of dissimilar steels TIGINOX 309 & TIGINOX 309L wires can be used.

CHAPTER 7

SUBMERGED ARC WELDING (SAW) WIRES & FLUXES

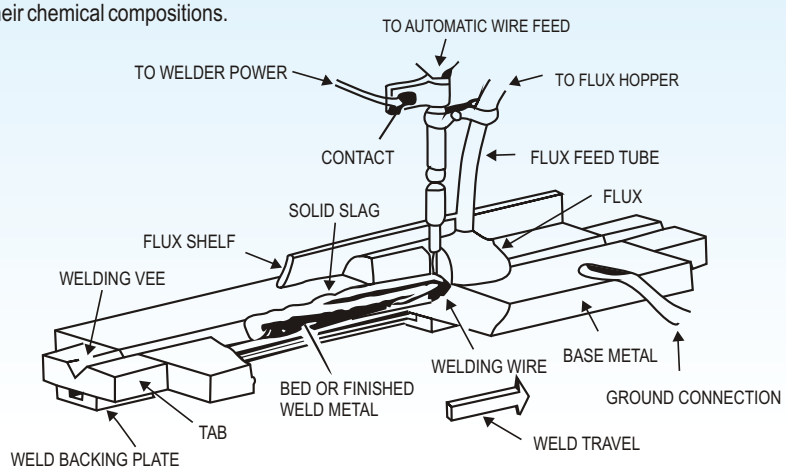
Ador Welding Limited has a wide range of wires and fluxes for submerged arc welding which are detailed below.

7.1 Wires for Submerged Arc welding (SAW)

Solid wires, as well as flux-cored wires for submerged arc welding are available.

Solid Wires for submerged Arc Welding

Some of the popular types in this range are described below along with their AWS / BIS classifications as well as their chemical compositions.



Brand Name	AWS A 5.17 / 5.23	IS 7280	C	Mn	Si	Mo
AUTOMELTEL 8	EL 8	AS-1	0.04	0.4	0.05	-
AUTOMELTEL12	EL12	AS-1	0.07	0.4	0.05	-
AUTOMELTEL 12K	EL12K	AS-2Si	0.08	1.0	0.20	-
AUTOMELTEL 10K	EH10K	-	0.09	1.5	0.18	-

Brand Name	AWS A 5.17 / 5.23	IS 7280	C	Mn	Si	Mo
AUTOMELTEL14	EH14	AS-4	0.015	1.9	0.05	-
AUTOMELT EA 3	EA 3	AS-4Mo	0.15	1.8	0.05	0.45
AUTOMELT EA 2	EA 2	-	0.08	1	0.1	0.45

These wires are supplied as standard packing in 25 Kgs spools. However, they are also supplied in 500 Kgs drum packing, depending on the requirements of the customers.

7.2 Fluxes for Submerged Arc Welding (SAW)

The range of submerged arc welding (SAW) fluxes comprises of :

- Acidic fluxes for submerged arc welding
- Basic fluxes for submerged arc welding
- Fluxes for submerged arc welding of stainless steels
- Hard facing fluxes for submerged arc welding

All SAW fluxes supplied by AWL are agglomerated types

Acidic Fluxes for Submerged Arc Welding

Some of the popular types of acidic fluxes for submerged arc welding are described below :

AUTOMELT A55

This flux is suitable for use with AUTOMELT EL8 wire as well as AUTOMELT EM12K wire. The weld deposits are of X-ray quality, the weld bead is smooth and shiny and the slag is easy to remove, even in root runs. The flux is used for submerged arc welding of structural, pressure vessels and boilers, LPG cylinders etc.

AUTOMELT A81

AUTOMELT A81 is Aluminate-rutile type of submerged arc welding of general structural steels, boiler & pipe steels as well as fine grained structural steels. It is active flux with high Si & Mn pickup. This is particularly suited for twin wire, tandem & multi-wire system at relatively high speed. Used for welding for X52, X56, X60, ASTMA36, 31 grades A, B, D, etc

Basic Fluxes for Submerged Arc Welding

Some of the popular types of basic fluxes for submerged arc welding are described below :

AUTOMELT B 31

This flux is suitable for use with AUTOMELT EH14 Wire as well as with AUTOMELT EA3 wire.

Typical applications include multi-pass welding of boilers and Pressure vessels, particularly thick-walled vessels where X-ray quality welds with impact at 40°C are required.

AUTOMELT B41

This flux is used for welding with AUTOMELT EH10K wire and applications include fabrication for the Nuclear power, Petrochemical and Offshore sectors where the highest quality of submerged arc welds are required. Good impact values at -60°C. This flux can also be used with low alloyed wires to deposit matching composition weld metals.

Fluxes for Submerged Arc Welding of Stainless steels

AWL supplies neutral fluxes for submerged arc welding of stainless steels. The weld metal chemistry is dependent on the type of stainless steel wire that is used, in combination with fluxes. Please contact our **Technology Development Centre (TDC)** for more details on these fluxes.

Productivity with submerged Arc Welding

Depositing more quantity of weld metal per shift without increased fatigue by individual welder can also be achieved by using the submerged Arc welding (SAW) process. The advantages of this process are similar to MIG welding and are described below :

- Increase in weld metal deposition rate
- Increase in depth of penetration into the base metal
- Increase in continuous arcing

Increase in Weld Metal Deposition Rate

The Weld metal deposition rate, in unit of kg /arc hour, is measured by the amount of weld metal deposited at given current level. In single pass or single pass per side welds, the welding speed per meter of joint increases with the SAW process. Likewise, in multi-pass welds the number of passes required to complete the joint, decrease considerably and the time to complete the joint reduces.

To illustrate, let us compare the deposition rate of MMAW, MIG Welding and SAW processes.

- The deposition rate for 5.0 mm, MMAW E 7018 electrode at 220 amps is 2.1 kgs / arc hour
- The deposition rate for 1.2 mm, MIG wire(ER 70S-6) at 250 amps is 4.2 kg / arc hour.
- The deposition rate for 1.6 mm, SAW EH 14 electrode at 400 amps is 6.2 kgs /arc hour.

Depth of Penetration into the Base Metal

The depth of penetration, in mm, is measured by the depth of fusion on unprepared surface, at a given current level and a given welding speed. Higher the depth of penetration, lesser is the need for joint preparation or back gouging. Multiple pass welds can be reduced to single pass or single pass per side welds, with less or no joint preparation or back gouging. Thus the joints can be completed faster. Let us Compare the depth of penetration of the MMAW, MIG welding and SAW processes.

- The depth of penetration for 5.0mm E 7018 electrode at 220 amps is 2 mm
- The depth of penetration for 1.2 mm, MIG wire (ER 70S6) at 250 amps is 3.5 mm
- The depth of penetration for 1.6 mm, SAW EH 14 electrode at 400 amps is 5mm

Increase in Continuous Arcing

In MMAW process the welder has to stop welding to take a new electrode. This interruption reduces the useful time of the welder to be used for arcing duty and weld metal deposition. In submerged Arc Welding, since the wire and flux are fed continuously, the arcing duty increases without increasing fatigue. Thus more weld metal can be deposited per welder.

Let us compare the arcing duty of the MMAW, MIG welding and SAW processes.

- The arcing duty possible with a manual 5.0 mm E 7018 electrode could be 25%
- The arcing duty possible with a 1.2 mm MIG wire could be 30%
- The arcing duty possible with mechanized 1.6 mm SAW EH 14 electrodes could be 40%

From the above examples, it is possible to understand the high productivity that can be achieved by using the SAW process.

CHAPTER 8 APPROVALS

8.1 Requirement of Approvals for Welding Consumables

Fabricators generally insist on the following information for all the welding consumables that they intend using.

1. The AWS or the BIS or other specifications to which the consumables conform.
2. Approval of the consumables by independent authorities such as BIS / RDSO / LRS etc.

Batch test certificates of the welding consumables from the manufacturers.

Conformance to AWS / BIS and other specifications

Manufacturers confirm in their specification sheets / handbooks, the specifications to which the consumables conform on the basis of the weld chemistry and the mechanical properties of the weld deposit. On request from the fabricators, manufacturers have to provide certificates confirming that the consumables supplied by them meet the specifications that they have mentioned in their specifications sheets / hand books.

Approval by independent Authorities

General Requirements

Consumables are approved by independent authorities to certify that they meet certain required standards are suitable for certain types of applications. These approvals are very important since the inspection authorities will not allow the usage of the consumables without these specific approvals.

These approvals also assure that the consumables are up to the required standards.

Pressure Vessels and Shipbuilding Repair Applications

For use of consumables on boilers, boiler tubes and all other components which come under the chief inspector of Boilers' jurisdiction, the approval must be obtained from chief inspector of boilers. Consumables used for ship building and ship repairs and on boilers and pressure vessels which are being supervised by Lloyd's Register of shipping, American Bureau of shipping, Bureau Veritas DNV, Indian register of shipping, have to be approved by these authorities. These approvals have to be renewed every year.

Railways Applications

Railway Design and standards organization (RDSO) of the Indian railways assessess consumables every year and put them under various Railway classifications like B1, B2,C1,C2 etc for fabricating structures for the railways certain classifications of electrodes for various jobs will be specified and only those electrodes which are approved by RDSO will be allowed to be used.

X-ray Quality Welding

The RDSO classification Class C2 which stands for radiographic quality welding electrodes is generally specified for jobs which need to pass radiographic standards.

ISI Mark

Electrodes are also approved by Bureau of Indian Standards institution and carry the popular ISI certification mark. This mark serves as a guarantee that the electrodes meet the minimum requirements of the specification mentioned on the mark.

Other Approvals

Likewise, fabricators will insist on approvals of consumables from independent approving authorities that the designers / consultants specify. Our welding consumables are approved by most of the approving authorities. In case any specific approval is required, please approach the **Technology Development Centre (TDC)**, who will assess the requirements and arrange approvals.

Welder Appeal

Please remember that these approvals only certify that the consumables conform to the minimum requirements. Among the consumables approved by the authorities some consumables are bound to be superior to others. Also remember that approvals are based only on mechanical / chemical properties of the weld metal.

Welders often prefer certain brands of electrodes because of their performance and what is called as “welder appeal” we give top most priority to the “welder appeal” aspect in every electrode we design.

Likewise the other consumables for MIG / TIG / SAW welding also are designed such that there is practically no wastage of consumables and minimum or no rework.

Batch Test Certificates

As mentioned earlier, manufacturers have to provide batch test certificate on the request of a fabricator so that the user is convinced that the consumables meet the specification that have been laid down in their specification sheets. AWL provides Batch Certificate with supplies of all consumables and you will note that the properties (chemistry/ mechanical) are consistent from batch to batch. This is the assurance a welder gets when using AWL Welding consumable.

8.2 ISO 9001:2000 - Quality Management System

What is ISO ?

- ISO (The International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies of which India is one).
- The work of preparing international standards is normally carried out through ISO technical committees.

You must often be hearing about compliance to ISO 9001 and ISO 2000. We are detailing below the salient features of these standards and AWL's conformance of these standards systems.

ISO 9001:2000 - Quality Management System

This edition was issued in the year "2008"

This standard addresses the six main clauses of ISO 9001:2008 in a quality (also called as APEX MANUAL)

- Management Responsibility
- Resource Management
- Product Realization
- Measurement, Analysis and Improvement


DNV BUSINESS ASSURANCE

Ador Welding Ltd.


DNV BUSINESS ASSURANCE
MANAGEMENT SYSTEM CERTIFICATE
ADOR WELDING LIMITED

Consumables Group got certified to the 1994 edition in 1998 under a common certification for all their plants. This was followed with a revision to the new edition of 2000 in the year 2001.

Under this standard our systems are maintained to assure consistent and superior products to the customers (through continuous improvement of our processes).

ISO 14001: 2004 Environment Management System Standards

This is the second edition of the ISO 14000 series **Environment Management System** standards, the first being issued in 1996.This edition was issued in the year 2004 and hence "2004".

Ador Welding Ltd. Consumables Group, got certified to the 2004 edition in April 2005 under a common certification for all their plants.

Currently we are in our 1st cycle of certification as per the latest edition.

Under this standard we need to maintain our systems to ensure that we do not cause pollution of an uncontrolled nature w.r.t. air, water, soil, noise and land.

Although manufacture of welding consumables is not classified as an environmentally hazardous industry in the list of processes, We have voluntarily opted for this certification in view of the growing environmental concerns that we have come across in our day-to-day life, as a social obligation.

This standard addresses the clauses of the ISO 14001:2004 in an Environment Management System Manual of Ador Welding Ltd. VIZ:

- Scope
- Environmental Policy
- EMS Planning (environment aspects/impact studies, legal and other requirements, objectives, targets and programmes)
- EMS implementation and operation [through resources, roles, responsibility and authority, competence, training and awareness, communication, documentation, control of documents, operational control (through OCP's) and emergency preparedness and response.]
- EMS checking (through Monitoring and measurement, evaluation of compliance, non-conformity review, corrective action and preventive action, control of records and internal audits)
- Management Review

Specific procedures have been written and implemented at the consumable plants on

a) Identifying the environment aspects of activities, products and services

b) Identifying and having access to legal and other requirements

c) Internal communication on EMS

d) Emergency preparedness

e) Monitoring and measurement of key characteristics

f) Periodic evaluation of compliance to environmental legislation and regulations

CHAPTER 9

UNDERSTANDING AWS & BIS CODES

Welding consumables have to conform to various specifications and codes. Generally fabricators use consumables conforming to AWS specifications. At times they also ask for BIS specifications. At times they also ask for BIS specifications, DIN specifications and others, depending on the requirements of the final user of the fabricated components. We are describing below some of the features of the AWS /BIS specifications applicable to welding consumables. For further details /clarification on these specifications and for information on other codes, please contact our **Technology Development Centre (TDC)** at Pune.

AWS Codes

Various AWS specifications applicable for the different steels and welding processes are described in the table below:

AWS FILLER METAL SPECIFICATIONS AT A GLANCE

METALS	SMAW	GTAW/GMAW & PAW	FCAW	SAW
C-Mn Steel	A5.1	A5.18	A5.20	A5.17
Low Alloy Steel	A5.5	A5.28	A5.29	A5.23
Stainless Steel	A5.4	A5.9, A5.22	A5.22	A5.9
Cast Iron	A5.15	A5.15	A5.15	-
Nickel Alloys	A5.11	A5.14	-	A5.14
Aluminum Alloys	A5.3	A5.10	-	-
Copper Alloys	A5.6	A5.7	-	-
Surfacing Alloys	A5.13	A5.21	A5.21	A5.21
Brazing Alloys	-	-	-	-
Tungsten Electrodes	-	A5.12	-	-
Consumable Inserts	-	A5.30	-	-
Shielding Gases	-	A5.32	A5.32	-

In this chapter we will discuss the AWS specifications for : SMAW electrodes for carbon Manganese, Low alloy high tensile steels and stainless steels. Wires for GMAW (MIG) Welding and GMAW(TIG) Welding Flux-cored Arc Welding (FCAW) Electrodes

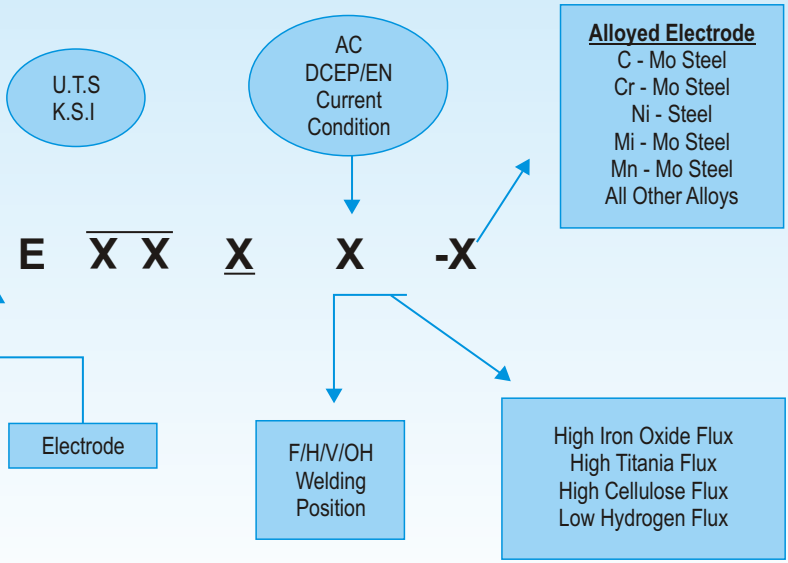
Consumables for submerged Arc welding (SAW)

SMAW Consumables for carbon Manganese and Low Alloy High Tensile steels

The table below describes the significance of the various digits in the AWS specifications

SMAW Consumable Classification

SFA/A5.1 & SFA / A5.5 FOR C-Mn & Low Alloy High Tensile steels



Carbon Manganese Steel Electrodes

The four types of flux coatings are described along with the properties expected from the electrodes manufactured with these flux coatings.

1. HIGH IRON OXIDE FLUX COVERED M.S. ELECTRODES							
AWS CLASS	**Flux Type**	**Position**	**Current Type**	**UTS (Mpa)**	**YS (MPa)**	**El.%**	**Impact Charpy -V**
E6019	Iron oxide Titania Potassium	All	AC DC±	414	331	22	-18°C 27J
E6020	High Iron oxide	F&H	AC DC±	414	331	22	XX

1. HIGH IRON OXIDE FLUX COVERED M.S. ELECTRODES

AWS CLASS	Flux Type	Position	Current Type	UTS (Mpa)	YS (MPa)	El.%	Impact Charpy -V
E6022	High Iron oxide	F& H	AC DC-	414	X	X	X X
E6027	High Iron oxide Iron powder	F& H	AC DC±	414	331	22	-29° C 27J

2. HIGH TITANIA FLUX COVERED M.S ELECTRODES

AWS CLASS	Flux Type	Position	Current Type	UTS (Mpa)	YS (MPa)	El.%	Impact Charpy -V
E6012	High Titania Sodium	All	AC DC-	414	331	17	X X
E6013	High Titania Potassium	All	AC DC+	414	331	17	X X
E7014	Iron powder Titania	All	AC DC+	482	399	17	X X
E7024	Iron powder Titania	F&H	AC DC+	482	399	17	X X

3. HIGH CELLULOSE FLUX COVERED M.S ELECTRODES

AWS CLASS	Flux Type	Position	Current Type	UTS (Mpa)	YS (MPa)	El.%	Impact Charpy -V
E6010	High Cellulose Sodium	All	DC+	414	331	22	-29°C27J
E6011	High Cellulose Potassium	All	AC DC+	414	331	22	-29°C27J

4. LOW HYDROGEN FLUX COVERED M.S ELECTRODES

AWS CLASS	Flux Type	Position	Current Type	UTS (Mpa)	YS (MPa)	El.%	Impact Charpy -V
E7015	Low Hydrogen Sodium	All	DC+	482	399	22	-29°C 27J
E7016	Low Hydrogen Potassium	All	AC DC+	482	399	22	-29°C 27J
E7018	Low Hydrogen Potassium Iron Powder	All	AC DC+	482	399	22	-29°C 27J
E7018-1	Low Hydrogen Iron powder	All	DC+	482	399	27	-46°C 27J
E7018-M	Low Hydrogen Iron powder	All	DC+	482	365	27	-29°C 27J

4.(a) LOW HYDROGEN FLUX COVERED M.S ELECTRODES

AWS CLASS	Flux Type	Position	Current Type	UTS (Mpa)	YS (MPa)	El.%	Impact Charpy -V
E7018-H4R	Low Hydrogen Moisture-resistant vacuum packed	All	AC DC+	482	399	22	-29°C27J
E7028	Low Hydrogen Potassium, Iron powder	F&H	AC DC+	482	399	22	-18°C 27J
E7048	Low Hydrogen Potassium, Iron powder	All & V ↓	AC DC+	482	399	22	-29°C27J

Low Alloy Steel Electrodes

- The coding is similar to carbon manganese steel electrodes as above, followed by a suffix
- The Suffix in the specifications designates the chemical composition of the weld metal. For three alloy content groups, the suffixes are as follows:

1. LOW ALLOYED STEEL ELECTRODES

SUFFIX	ALLOY CONTENT GROUP
EXXXXA1	C&0.04 – 0.65 Mo
EXXXXB1	0.40-0.65 Cr & 0.40-0.65 Mo
EXXXXB2	1.00-1.50 Cr & 0.40-0.65 Mo
EXXXXB3	2.00-2.50 Cr & 0.90-1.20 Mo
EXXXXB4	1.75-2.25 Cr & 0.40-0.65 Mo
EXXXXB5	0.40-0.60 Cr & 1.00-1.25 Mo
EXXXXB6	4.00-6.00 Cr & 0.45-0.65 Mo
EXXXXB7	6.00-8.00 Cr & 0.45-0.65 Mo
EXXXXB8	8.00-10.50 Cr, 0.85-1.20 Mo
EXXXXB9	8.00-10.50 Cr, 0.85-1.20 Mo with extra V, Cu, Al, Nb & N

2. LOW ALLOYED STEEL ELECTRODES

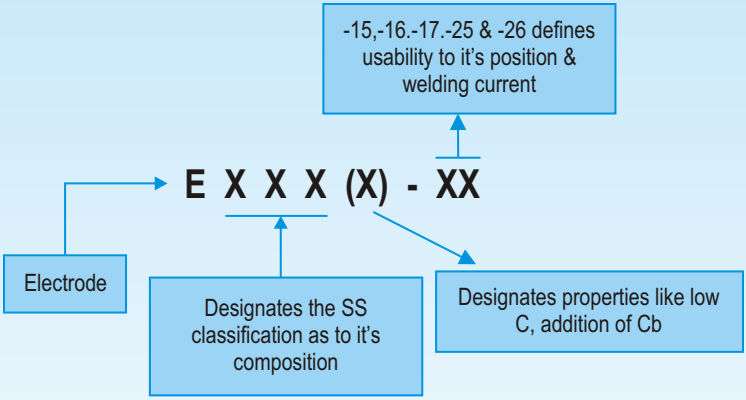
SUFFIX	ALLOY CONTENT GROUP
EXXXXC1	2.00-2.75 Nickel Electrodes
EXXXXC2	3.00-3.75 Nickel Electrodes
EXXXXC3	0.80-1.10 Ni, 0.15 Cr, 0.35 Mo & 0.05V

2. LOW ALLOYED STEEL ELECTRODES	
SUFFIX	**ALLOY CONTENT GROUP**
EXXXXC5	6.00-7.25 Ni
EXXXXNM1	0.80-1.0 Ni, 0.10 Cr. 0.40-0.65 Mo, 0.02V, 0.10 Cu & 0.05 A1
EXXXXD1	1.00-1.75 Mn, 0.90 Ni & 0.25-0.45 Mo
EXXXXD2	1.65-2.00 Mn, 0.90 Ni & 0.25-0.45 Mo

3. LOW ALLOYED STEEL ELECTRODES	
SUFFIX	**ALLOY CONTENT GROUP**
EXXXXD3	1.00-1.80 Mn, 0.90 Ni & 0.40-0.65 Mo
EXXXXG	1.00 min. Mn, 0.50 min Ni, 0.30 min. Cr 0.20 min. Mo, 0.10 min V & 0.20 min. Cu
EXXXXM	1.40-1.80 Ni, 0.15 Cr, 0.35 Mo & 0.05V
EXXXXM1	3.00-3.80 Ni, 0.65 Cr, 0.20-0.30 Mo & 0.05V
EXXXXP1	1.00 Ni.0.30 Cr, 0.50 Mo & 0.10V
EXXXXW1	0.20-0.40 Ni, 0.15-0.30 Cr, 0.08V & 0.30-0.60 Cu
EXXXXW2	0.40-0.80 Ni, 0.45-0.70 Cr & 0.30-0.75Cu

Stainless Steel Electrodes

The table below describes the codification of the Stainless Steel Electrodes as per AWS A5.4



The table below describes the welding current and position of welding as per the suffix in the electrode.

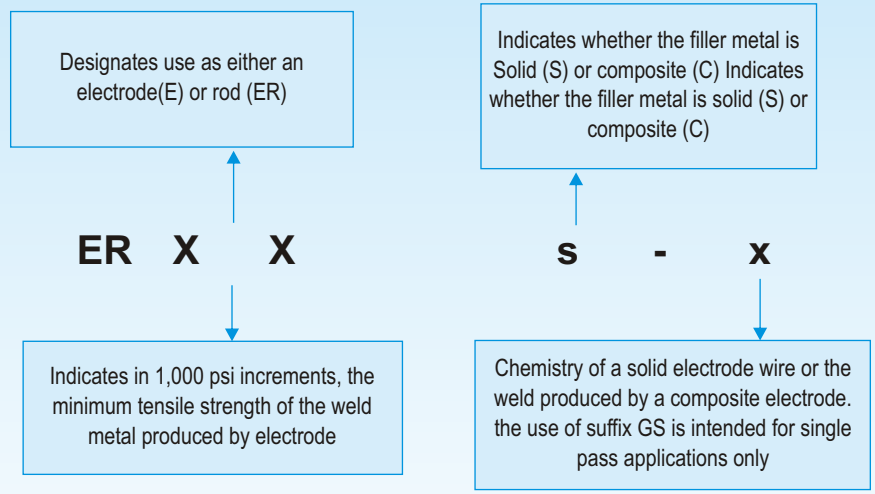
Types of Welding Current & Position of Welding

AWS CLASSIFICATION	WELDING CURRENT	WELDING POSITIONS
E XXXX(X)-15	DC+	Flat, Horizontal, Vertical & Overhead
E XXXX(X)-25	DC+	Flat & Horizontal
E XXXX(X)-16	AC, DC+	Flat, Horizontal, Vertical & Overhead
E XXXX(X)-26	AC, DC+	Flat & Horizontal
E XXXX(X)-17	AC, DC+	Flat, Horizontal, Vertical & Overhead

- 15/25 Basic flux
- 16/26 Flux for AC/DC Welding
- 17 Flux is party replaced by SiO2

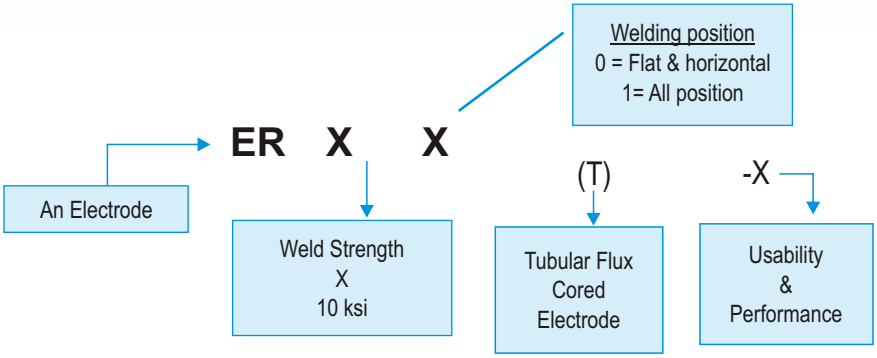
Wires for GMAW (MIG)& GTAW (TIG) Welding

The table below describes the classification for mild and carbon steel wires used for GMAW / GTAW as per AWS A5. 18.



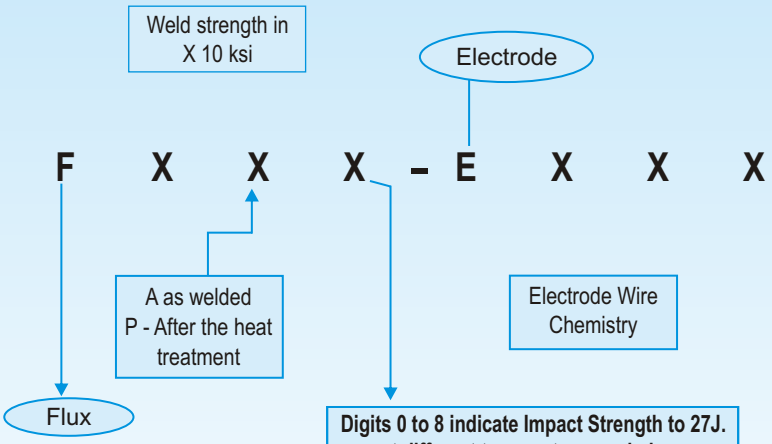
Flux - cored Arc welding (FCAW) Wires

The classification for Flux-cored Arc Welding Consumables as per AWS A5.20 is as below :



Consumables For Submerged Arc Welding

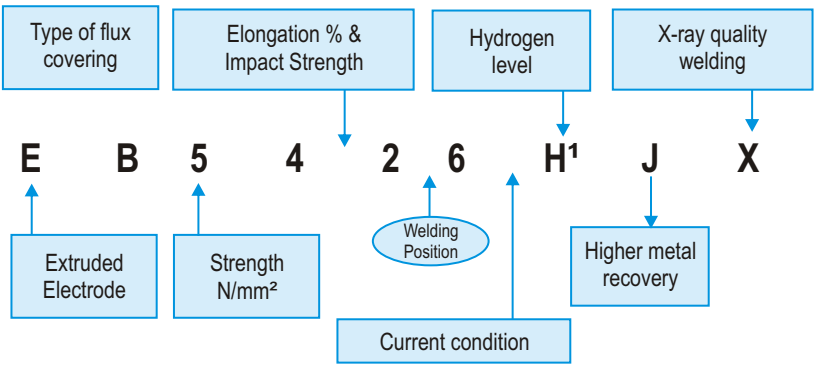
The mild steel & LAHT steels SAW consumables classification as per AWS A5.17 is described below:



Digits 0 to 8 indicate Impact Strength to 27J. at different temperatures as below:	
0 at 0°F	5 at - 50°F
2 at - 20°F	6 at - 60°F
4 at - 40°F	8 at - 80°F

BIS Specifications for Carbon Manganese Steel Electrodes

IS 814 1991 Describes the SMAW electrodes as below :



Extruded Electrodes

The first alphabet E signifies that it is an extruded electrode.

Flux Covering

The types of flux covering are designated by the second alphabet and are described below :

A Acidic

B Basic

C Cellulosic

R Rutile

RR Rutile, heavy coated

S Other types

Strength

The strength of the weld metal is described by the 1st digit after the 2 alphabets as below :

Designating digits	4	5
U.T.S / mm²	410-510	510-610
Y.S N / mm²	330	360

The elongation % and impact strength are defined by a combination of the first digit (nos. 4 or 5) With the 2nd digit as described below :

(a) Combination of no. 4 (of 1st digit) with the corresponding no. of 2nd digit shows elongation % and impact strength as below:

Elongation % & Impact strength

Number	Elongation %	Impact Strength
0	Not required	Not required
1	20%	47J / +27° C
2	22%	47J / 0° C
3	24%	47J / -20° C
4	24%	47J / -30° C

(b) Combination of no. 4 (of 1st digit) with the corresponding no. of 2nd digit shows elongation % and impact strength as below :

Elongation % & Impact strength

Number	Elongation %	Impact Strength
0	Not required	Not required
1	18%	47J / +27° C
2	18%	47J / 0° C
3	20%	47J / -20° C
4	20%	27J / -30° C
5	20%	27J / -40° C
6	20%	27J / -40° C

Welding Position

The 3rd digit defines the welding position from Nos.1 to 6 as below :

1. All Position Welding
2. All Position Welding except vertical down
3. Flat position only - for but & fillet weld
4. Flat position butt and flat & horizontal for filler
5. Vertical down, flat but, flat & horizontal fillet
6. Any other welding position classified above

Welding current & voltage conditions are defined by the 4th digit from Nos.

0 to 9 as below :

0	DC+	5	DC- AC (70V)
1	DC± : AC (50V)	6	DC+ : AC (70V)
2	DC- : AC (50V)	7	DC± : AC (90V)
3	DC+ : AC (50V)	8	DC- : AC (90V)
4	DC± : AC (70V)	9	DC+ : AC (90V)

Hydrogen content / 100g weld metal is defined by suffixes as below :

Suffix H_1 = Up to 15 ml diffusible hydrogen

Suffix H_2 = Up to 10 ml diffusible hydrogen

Suffix H_3 = Up to 5 ml diffusible hydrogen

Higher metal recovery is defined by suffixes j K & L as described below :

Suffix J is for 110 to 129% metal recovery

Suffix K is for 130 to 149% metal recovery

Suffix L is for 150% and above metal recovery

X-ray quality welding electrodes

The suffix X denotes that it is a radiographic quality welding electrode.

CHAPTER 10

HARDNESS CONVERSION SCALES

Vickers or Diamond Pyramid Hardness	Rockwell Hardness		Brinell Hardness, HB HBr, BHN	
HV,VHN,VPN,DPN	C scale HRC,R_C	B scale HRB,R_B	Steel Ball	Tungsten Carbide Ball
1000	69	-	-	-
950	68	-	-	-
900	67	-	-	-
850	66	-	-	750
800	64	-	-	722
750	62	-	-	691
700	60	-	-	656
650	58	-	-	611
600	55	-	-	564
580	54	-	-	545
560	53	-	-	525
540	52	-	496	507
520	51	-	480	488
500	49	-	465	471
480	48	-	448	452
460	46	-	433	433
440	45	-	415	415
420	43	-	397	397
400	41	-	379	379
380	39	-	360	360
360	37	-	341	341
340	34	-	322	322
320	32	-	303	303
300	30	-	284	284
280	27	-	265	265

HARDNESS SCALES

contd.

Vickers or Diamond Pyramid Hardness	Rockwell Hardness		Brinell Hardness, HB HBr, BHN 750	
HV,VHN,VPN,DPN	C scale HRC,R_C	B scale HRB,R_B	Steel Ball	Tungsten Carbide Ball
260	24	-	247	247
240	20	98	228	228
220	-	95	209	209
200	-	92	190	190
180	-	87	171	171
160	-	82	152	152
140	-	75	133	133
120	-	67	114	114
100	-	56	95	95

This table must be regarded as giving no more than a general indication of the hardness relationships for steels.

Conversions and Information

Electrode Size Equivalents

Diameters			Length	
mm	SWG	in	mm	in
1.6	16	1/16	250	10
2	14	5/64	300	12
2.5	12	3/32	350	14
3.25	10	1/8	400	16
5	8	5/32	450	18
4	6	3/16	600	24
6	4	1/4		
7	2	9/38		
8	-	5/16		

Basic Conversion Factors

To Convert	into:	Multiply by:
(N.B.Factors ending in 0 are exact)		
in	mm	25.40
mm	in	0.0393 701
ft.	m	0.304 8
m	ft.	3.280 839 8
lb	kg	0.453 592 370
kg	lb	2.204 62
ton(long)	tonne	1.016 05
tonne	kg	1000.0
gallon(imp)	1(litre)	4.545 96
1	m1	1000.0
m1	cm^3	1.000 028
cu. ft	1	28.316 1

Approximate Metal Densities (g/cm^3 at $+20^0$ C)

Steel,	0.6% C/o . 4% Mn	7.87
Steel,	0.1% C/5% Cr .	7.81
Steel,	0.15% C/13% Cr .	7.74
Steel,	0.2% C/26% Cr .	7.66
Stainless Steel 19%Cr/10%Ni/0.3%C		7.93
Stainless Steel 25%Cr/20%Ni/0.2%C		7.9
Aluminum, Commercial Purity		2.7
Al/1.3%Mn		2.74
Al/11%Si		2.65
Copper. O.F.H.C		8.94
Cu/7.5%Sn/0.2%P		8.9

Compound Conversion Factors

tonf /in^2	N/mm^2	15.444 3
lbf/in^2	N/mm^2	0.006 894 777
N/mm^2	$tonf/in^2$	0.064 749
N/mm^2	lbf/in^2	145.037 76
ft.lbf	J(Joules)	1.355 82
kgf.m	J	9.806 650
kgf.m	ft.lbf.	7.23301
ft.ibf	kgf.m	0.138 255
J	ft.ibf.	0.737 562
in/mim	m/hr	1.524 0
m/hr	in/min	0.656 168
cu.ft/hr	1/min	0.471 95
1/min	cu.ft/hr	2.118 936
lb.cu.fr.	g/cm	30.01 602
g/cm3	lb/cu.ft.	62.43

(See also BS 350Conversion Factors and Tables)

Symbols for Chemical Elements

Al	Aluminium	Ni	Nickle
C	Carbon	O	Oxygen
Co	Cobalt	P	Phosphorus
Cr	Chromium	Pb	Lead
Cu	Copper	S	Sulphur
H	Hydrogen	Si	Silicon
Fe	Iron	Sn	Tin
Mg	Magnesium	Ta	Tantalum
Mn	Manganese	Ti	Titanium
Mo	Molybdenum	V	Vanadium
N	Nitrogen	W	Tungsten
Nb	Niobium	Z	Zinc

Metric Multiplying Factors

Prefix		Value
Name	Symbol	
mega	M	x 10^6
Kilo	K	x 10^3
hecto	h	x 10^2
deca	da	x 10
deci	d	x 10^{-1}
Centi	e	x 10^{-2}
milli	m	x 10^{-3}
micro	“	x 10^{-6}

Welding Data Tables

Square Butt Joints

Position	Plate Thickness mm	Gap mm	Volume/length cm²/m	Weight/Length (steel) kg/m
 Flat	1 1.5 2 3	0 0.5 1 1.5	2 3 4 7	0.02 0.02 0.03 0.05
 Flat	4 5 6 7	2 2 2.5 3	17 21 27 36	0.13 0.16 0.21 0.28
 Horizontal-Vertical	1 1.5 2 3	0 0.5 1 1.5	2.5 4 5 9.5	0.02 0.03 0.04 0.07
 Horizontal-Vertical	4 5 6 7	2 2.5 3 3	22 25 32 42	0.17 0.20 0.25 0.33
 **Overhaed**	4 5 6 7	2 2 2.5 3	9 10.5 13 16	0.07 0.08 0.10 0.13
	4 5 6 7	2 2 2.5 3	10.5 16 18 21	0.08 0.13 0.14 0.16

THE FIRST RUN AND BACKING RUN

Position	Plate Thickness mm	Weight/Length kg/mm	Electrode Size mm
Flat	6 -12	0.10	3.15
Flat	> 12	0.15	4
Vertical	> 8	0.15	3.15
Horizontal - Vertical	> 8	0.15	3.15
Overbold	> 10	0.10	3.15

FILLET WELDS

Throat Thickness	Section Size	1		2		3		4	
mm	mm^2	cm^3/m	kg/m	cm^3/m	kg/m	cm^3/m	kg/m	cm^3/m	kg/m
2	4	5	0.04	6	0.05	5.5	0.04	5.5	0.04
2.5	6.5	7.5	0.06	8.5	0.07	8	0.06	8.5	0.07
3	9	10.5	0.08	12.5	0.10	11	0.09	12	0.09
3.5	12.5	14	0.11	16	0.13	15	0.12	16.5	0.13
4	16	18	0.14	21	0.16	19.5	0.15	22	0.17
4.5	20.5	22.5	0.18	26	0.20	24.5	0.19	26.5	0.21
5	25	27.5	0.22	31.5	0.25	30.5	0.24	33	0.26
5.5	30.5	33.5	0.26	37	0.29	36	0.28	40.5	0.32
6	36	40	0.31	42	0.33	43	0.34	47.5	0.37
6.5	42.5	46.5	0.37	49.5	0.39	51	0.40	56	0.44
7	49	54.5	0.43	57	0.45	56	0.44	65	0.51
7.5	56.5	60.5	0.47	65	0.51	64	0.50	73.5	0.58
8	64	70	0.55	73.5	0.58	76.5	0.60	82.5	0.65
9	81	88	0.69	94	0.74	95	0.75	109	0.86
10	100	108	0.85	114	0.89	116	0.91	130	1.02
11	121	131	1.03	138	1.08	143	1.12	157	1.23
12	144	155	1.22	162	1.27	169	1.33	188	1.48
13	169	179	1.41	190	1.49	195	1.53	220	1.73
14	196	207	1.62	224	1.76	227	1.78	257	2.02
15	225	237	1.86	248	1.95	264	2.07	294	2.31

SINGLE V - JOINTS





Plate Thickness	Gap	50° Flat			60° Flat			70° Vertical			80° Overhead			60° Horizontal-Vertical		
		Theoretical Volume Weld			Theoretical Volume Weld			Theoretical Volume Weld			Theoretical Volume Weld			Theoretical Volume Weld		
mm	mm	cm^3/m	cm^3/m	kg/m	cm^3/m	cm^3/m	kg/m	cm^3/m	cm^3/m	kg/m	cm^3/m	cm^3/m	kg/m	cm^3/m	cm^3/m	kg/m
4	1	11.5	11	0.09	13	12.5	0.10	15	16.5	0.13	17.5	18	0.14	13	14.5	0.11
5	1	16.5	16	0.13	19.5	19	0.15	22.5	24.5	0.19	26	2.0	0.22	19.5	21	0.16
6	1	23	21.5	0.17	27	25.5	0.20	31	37	0.29	36	38.5	0.30	27	30	0.24
7	1.5	33.5	32.5	0.26	39	38	0.30	45	49	0.38	51.5	56	0.44	39	42	0.33
8	1.5	42	40	0.31	49	46.5	0.37	57	59.5	0.47	65.5	70	0.55	49	56	0.44
9	1.5	51	48	0.38	60.5	56	0.44	70	75.5	0.59	81.5	87.5	0.69	60.5	65	0.51
10	2	66.5	62	0.49	77.5	72	0.57	90	96.5	0.76	104	109	0.86	77.5	81	0.64
11	2	78.5	71.5	0.56	92	83.5	0.66	107	113	0.89	124	130	1.02	92	96.5	0.76
12	2	91	83	0.65	107	97.5	0.77	125	134	1.05	145	157	1.23	107	113	0.89
14	2	120	110	0.86	141	130	1.02	165	171	1.34	193	204	1.60	141	149	1.17
15	2	135	123	0.97	160	146	1.15	188	197	1.55	219	231	1.81	160	171	1.34
16	2	151	132	1.04	180	157	1.23	211	223	1.75	247	257	2.02	180	186	1.46
18	2	189	170	1.33	223	204	1.60	263	276	2.17	308	320	2.51	223	233	1.83
20	2	227	208	1.63	271	247	1.94	320	334	2.62	376	396	3.11	271	281	2.21

CHAPTER 11 SAFETY FEATURES

Welding is a safe operation when sufficient measures are taken to protect the welder from potential hazards. When these measures are overlooked or ignored, welders can encounter dangers such as electric shock, over exposure to fumes and gases, arc radiation, fire and explosion which may result in serious or even fatal injuries.

11.1 What is Personal Protective Equipment?

Personal Protective Equipment, commonly referred to as **"PPE"**, is equipment worn to minimize exposure to serious workplace injuries and illnesses. These injuries and illnesses may result from contact with chemical, radiological, physical, electrical, mechanical or other workplace hazards. PPE may include items such as gloves, safety glasses and shoes, earplugs or muffs, hard hats, respirators or coveralls, vests and full body suits.

What can be done to ensure proper use of PPE ?

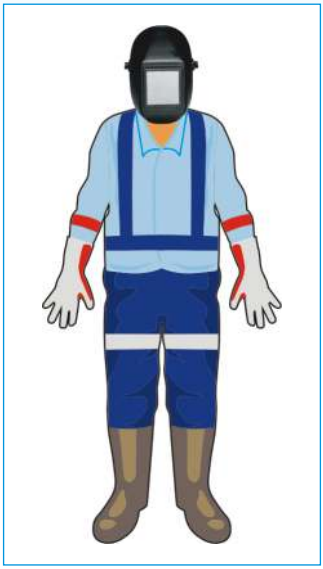
All PPE should be of safe design and construction and should be maintained in a clean and reliable fashion. It should fit well and be comfortable to wear, encouraging welder to use them.

11.2 Protective Clothing

Welder, must wear clothing to protect them from being burned. Injuries like burns are the most common due to sparks landing on bare skin. Welding arcs are very intense and can cause burns to skin and eyes with just a few minutes of exposure. Many types of clothing will protect you from ultra-violet radiation exposure, which appears as a skin burn (much like sunburn).

Under the worst conditions, severe burns and skin cancer may result from excessive radiation. Because of its durability and resistance to fire, wool clothing is suggested over synthetics (which should never be worn because it melts when exposed to extreme heat) or cotton, unless it is specially treated for fire protection.

If possible keep your clothes clean of grease and oil, as these substances may ignite and burn uncontrollably in the presence of oxygen. Other protective wear for heavy work or especially hazardous situations includes flame-resistant suits, aprons, leggings, leather sleeves/shoulder capes and caps worn under your helmet. Heavy flame-resistant gloves such as leather should always be worn to protect your hands from burns, cuts and scratches.

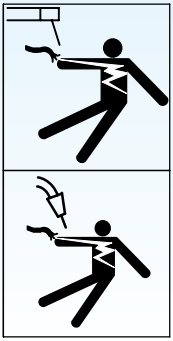


In addition, as long as they are dry and in good condition, they will offer some insulation against electric shock. In order to prevent electric shock, the key word is dry! When working in wet conditions or when perspiring heavily, you must be even more careful to insulate your body from electrically live parts and work on grounded metal.

11.3 Carrying out welding operations exposes the welder to Safety Hazards in following areas

1. Electric Shock
2. Electromagnetic Radiation
3. Fire & Explosion
4. Fumes & Gases
5. Heat

1. ELECTRIC SHOCK



Arc welding equipments operate at a voltage which is safe under normal working conditions but the shock hazard should not be ignored. It increases in warm & damp conditions because welder has to work with electric current which may pass through his body. The human body resistance to current passage is not constant. The highest resistance is offered by the skin. Wet skin conducts electric current better than dry skin under normal conditions.

Safety Precautions

- Check that equipment is correctly earthed when installed & when in use
- Make sure welding cables and machines are capable of handling maximum voltage & current as rated for the equipment & for the desired applications
- Check for damage to insulation on cables, holders, guns and connectors, please do not operate the equipment without properly insulting the same
- Ensure Arc welding machines are designed as per applicable standards
- Please operate equipments strictly as per printed Instructions and rules specified by respective original equipment manufacturers
- Make sure all earthing connections are mechanically strong
- Ensure all welding equipments are inspected regularly
- Do not immerse hot electrode holder into water for cooling because retained moisture may give electric shock in later operations
- Do not carry holder and earthing together when welding machine is ON
- Always wear rubber soled safety shoes

2. ELECTROMAGNETIC RADIATION

The welding arc provides intense visible and invisible light (or radiation) and heat. Eyes must be protected from ultraviolet and infrared radiation to avoid Arc Eyes and Arc Burns. Light intensity of welding arc is 10,000 times that of the safe unit for human body. A welding arc should not be looked at with unprotected eyes. Failure to observe this rule may result in various degrees of eye burn or flashed eyes (Arc eyes). The affected person has pronounced irritations in the eyes and feels as if there is sand in the eyes. The symptoms remain for one to two days. Radiation effects are up to a distance of 15 meters.

Safety Precaution

- Do not look at welding arc with naked eyes
- Use heat - resisting quality of welding screen
- Use helmet or face shield fitted with the correct shade of filter glass
- Do not use cracked or defective helmets or shield
- If possible, coat individual welding booths with a mat & light absorbent type of paint with a very low reflecting quality
- Use safety clothing (safety shoes, leather hand gloves, leather apron, leather leggings and leather cap) when welding

2. FIRE & EXPLOSION

What is Fire?

When any material starts burning, we call it Fire.

Material (fuel) starts burning on application of heat in presence of air and oxygen.

Any fire requires three supports - fuel, oxygen and ignition, when these three meet proportionately with each other, then a fire breaks out.

When an outbreak of fire is discovered, immediate corrective action is essential to provide life and damage to property.

What is Explosion?

It is very rapid process of combustion, accompanied by rapid liberation of heat and formation of a very large volume of gases products.

Fire can be controlled by reducing Fuel or Heat of air.

Before extinguishing any fire, it is essential to known the classification of fire.

When material burns, it behaves in different manners, depending upon it's physical properties. Extinguishing depend on these physical properties. Portable extinguishers are used in accordance with the extinguishing method.

Safety Precautions

- While repairing tanks, vessels, drums or pipes by welding or gas cutting, remove all traces of earlier stored material to avoid possibility of explosion

- Remove all flammable materials from working areas
- Avoid excessive release of fuel gas into the atmosphere
- Ensure that appropriate fire fighting equipment is available at hand and that all concerned know how to use it
- Have a bucket of water at the work station for cooling overheated blow pipes
- Where a 'Permitted to work' system is in operation, ensure that all instruction are fully complied with
- Check emergency escape route

4. FUMES & GASES

Proper ventilation is a must to maintain good health. It is true that when a welder gets clean air to breathe, he can see better, work better, work longer, quality of his work improves & productivity of people working nearby increases in an improved environment.

Most common toxic fumes are from materials such as Zinc Oxide, Carbon Monoxide, Mercury, Lead and Cadmium.

Safety Precautions

- Carry out all welding operations in safe, clean and at location where sufficient natural air circulation is available.
- Under normal workshop conditions, use a local fume extractor wherever possible and maintain it's position close to the weld as work progresses
- Check for possible toxic hazards from parent metal (especially if surface is pained, plated or chemically treated) or from welding consumables
- Check for adequate ventilation and/ or breathing apparatus when welding in an enclosed space
- Use a face respirator when toxic fumes are present

5. HEAT

Heat & Spatter are expelled during cutting and welding. The work piece will remain hot for some time after welding.

Safety Precautions

- Wear correct protective clothing in good condition, free from grease and oil
- Treat all metal connected with welding and cutting as HOT
- Mark work piece as HOT when it is hot (remove notice when cool)

Our Network - Area Offices

Ahmedabad 804-805, Sakar IV, Near Ellisbridge, Ahmedabad - 380 006, Gujrat **Area Covered: Gujarat** Tel. No.: (079) 2657 9928 / 6661 2788 Fax No.: (079) 6661 2788	**Bengaluru** N-406/407, North Block, Rear Wing, Manipal Center, Dickenson Road, Bengaluru - 560042, Karnataka **Area Covered: Karnataka & Tamilnadu** (excluding Coimbatore & Trichy) Tel. No.: (080) 2558 5125 Fax No.: (080) 2532 1477
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Delhi C-116, Naraina Industrial Area, Phase 1, New Delhi - 110 028 **Area Covered: NCR (Including** **Faridabad & Gurgaon) UP,** **Uttarakhand & Nepal** Tel. No.: (011) 4330 4333 / 4141 1106 / 4141 1049 / 4557 8099 Fax No.: (011) 2579 5529	**Hyderabad** 9-1-93/1, Lane Adjacent to Sangeet Cinema, Sarojini Devi Road, Secundarabad - 500 003, Andhra Pradesh **Area Covered: Andhra Pradesh** Tel. No.: (040) 2771 2090 / 6649 2090 Fax No.: (040) 2771 5570
Indore 402, Apollo Trade Center, Ambedkar Square, Geeta Bhavan - Chouraha, A. B. Road, Indor - 452 001, M.P. **Area Covered: Madhya Pradesh,** **Waidhan, Chattishgarh** Tel. No.: (0731) 2494220 / 4066840 Fax No.: (0731) 4066840	**Jaipur** 309, Aishwarya Tower Ajmer Road Jaipur 302 006 Tel. No.: +91 141-2220833 Fax No.: +91 141-2220834

Our Network - Area Offices

Kolkata P-6 C.I.T. Road, Scheme - 55, Moulali, Kolkatta 700 014, West Bengal. **Area Covered: West Bengal, Jharkhand, Blhar, Bangaladesh & Bhutan** Tel. No.: (033) 4008 4862 / 63 Fax No.: (033) 4008 4864	**Mumbai** Ador House, 6, K. Dubash Marg, Fort, Mumbai 400 001-16, Maharashtra. **Area Covered: Mumbai, Thane, Raigarh, Ratnagiri** Tel. No.: (022) 6623 9300 / 35 Fax No.: (022) 2596 6562 / 6062
Pune P.B. No 2, Akurdi, Chinchwad, Pune - 411 019, Maharashtra **Area Covered: Maharashtra (excluding Raigarh, Ratnagiri) & Goa** Tel. No.: (020) 4070 6000 Fax No.: (020) 4070 6001	**Registered Office:** Ador House, 6, K. Dubash Marg, Fort, Mumbai 400 001. INDIA. Email: cmo@adorians.com Tel. No.: +91 22 2284 2525./ 6623 9300 Fax No.: +91 22 2287 3083 / 2596 6562 / 2596 6062

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Our Global Footprints

INDIA	MIDDLE EAST	AFRICA	ASIA, EUROPE & US
• Delhi	• Dubai	• Nairobi	• Kathmandu
• Jaipur	• Sharjah	• Kampala	• Myanmar
• Ahmedabad	• Abu Dhabi	• Dar E salaam	• Vietnam
• Indore	• Muscat	• Blantyre	• Singapore
• Silvassa	• Sohar	• Khartoum	• Jakarta
• Mumbai	• Doha	• Algiers	• Lahore
• Pune	• Kuwait	• Senegal	• Baku Azerbaijan
• Bengaluru	• Tehran	• Ghana	
• Coimbatore	• Jordan	• Lagos	• Italy
• Chennai	• Iraq	• Cairo	
• Hyderabad	• Jubail	• Addis Ababa	• Salt Lake City
• Raipur	• Dammam	• Mombasa	• Utah
• Kolkata	• Manama	• Congo	
	• Riyadh	• Angola	
	• Sanaa		
	• Jeddah		

Regd. & Corporate Office

Manufacturing Facilities

Central Marketing Office

Disclaimer: This map is not to the scale. It is only geographical representation. Company does not take any responsibility of the accuracy of the same.

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Regd. & Corp. Office: Ador House, 6, K. Dubash Marg, Fort, Mumbai - 400 001-16, Maharashtra. India. Tel.: +91 22 6623 9300 / 2284 2525 | Fax: +91 22 2287 3083

Sharjah Airport International Free Zone (SAIF Zone) Q3 - 216, P.O. Box No.: 120025 Sharjah - U.A.E. Tel.: 00971 6 5578601 | Fax: 00971 6 5578602 | E-mail: awloverseas@adorians.com

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